SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LI DECEMBER, 1930 NUMBER 6

THE DEVELOPMENT OF CANCER IN BURN SCARS

AN ANALYSIS AND REPORT OF THIRTY-FOUR CASES[1]

NORMAN TREVES, A.M., M.D., F.A.C.S., NEW YORK
Assistant Attending Surgeon
AND
GEORGE T. PACK, B.S., M.D., NEW YORK
Fellow of Cancer Research

BIOGRAPHICAL NOTE

Jean-Nicolas Marjolin was born at Ray-sur-Saone on December 6, 1780. He completed his preparatory education at Commercy and later studied medicine at the University of Paris. He pursued his medical course with assiduity and in 1801 won first prize as a clinical interne. His first appointment on the medical faculty was an assistantship and prosectorship in the department of anatomy. He received his doctorate degree in 1808. In 1812 he was an unsuccessful competitor of Dupuytren for the chair of operative medicine in the University of Paris. He became second surgeon to the Hotel-Dieu of Paris in 1818 and later was surgeon to the Beaujon Hospital. In 1819 Marjolin was appointed to the chair of surgical pathology of the faculty of medicine. After 1830, he was consultant surgeon to Louis-Philippe.

Marjolin was a better consultant surgeon than a practicing surgeon. Although he was a teacher of high repute, a surgeon of more than average ability, and a consultant of distinction, yet he never made any notable discoveries. His clientele was composed principally of very wealthy patients, in consequence of which he acquired a considerable fortune and abandoned surgery so that he might devote his time to horticulture. He died in Paris on March 4, 1850.

The eponym which bears his name, "Marjolin's ulcer," was derived from his lucid description of the carcinomatous ulcers, which originate on degenerating scars. In 1828, over one hundred years ago, he described these lesions in the *Dictionnaire de Medecine pratique:*

"La surface de ces ulcères est formée par un tissu composé d'un grand nombre de villosités coniques, d'une texture dense, serrée, très rapprochées les unes des autres, représentant en quelque sorte un velours de laine grossier. Ces ulcérations laissent suinter en petite quantité un fluide visqueux presque incolore, fétide, qui en se desséchant forme une croûte épaisse, dure, grisâtre, très adhérente. Ils sont peu douloureux au même indolents et susceptibles de prendre une grande étendue."

DURING the twelve year period from January 1, 1917, to January 1, 1929, 1,091 patients with epidermoid carcinoma of the skin and 1,374 patients with basal cell carcinoma of the skin were treated at the Memorial Hospital. These cancers developed on the basis of burn scars, new and ancient, in 28 instances; 21 were epidermoid carcinomata and 7 were basal cell epitheliomata. From these data we have estimated that 2 per cent of all epidermoid carcinomata and 0.3 per cent of all basal cell carcinomata originate on skin subjected to thermal injuries. We are unable to determine the incidence of such cancers with relation to the number of burn scars.

HISTORICAL NOTE

Celsus observed the development of cancer in burn scars. In 1828, Marjolin published his classical description of the ulcer which originates in degenerating scars and which is known today as "Marjolin's ulcer."

In 1839, Dupuytren related the case history of a Belgian who was treated for an enormous cancer which arose on the scar of a burn by sulphuric acid. He described the instance in his *Leçons orales de clinique chirurgicale:*

"C'est ainsi, dit-il, qu'il y a quelques années, je fus obligé de pratiquer l'amputation de la jambe à un

[1]From the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York City. Aided by a grant from the Mrs. John L. Given Fund. Read by invitation before the Surgical Section, New York Academy of Medicine, October 3, 1930.

habitant de la Belgique pour un vaste cancer qui lui était survenu sur la cicatrice d'une brûlure profonde faite dans son jeune âge par de l'acid sulfurique répandu sur l'articulation du pied avec la jambe, le pied et la partie inferieure de la jambe. Cet individu avait pourtant passé sa jeunesse et son âge mûr sans aucune espèce d'accident. Le cancer ne se déclara sur la cicatrice actuellement tiraillée qu'aux approches de la viellesse."

The English surgeon, Cæsar Hawkins, in 1825 reported two epitheliomata, which had developed in the scars of English soldiers, who had been burned in India, 11 and 27 years before the inception of the cancer. The French physician, Heurtaux, wrote a brochure on this subject in 1860. Broca observed an epithelioma in an ulcerated scar on a man aged 75 years; he reported this observation in 1862 and stated that the patient was burned 51 years before (1811) when he was 24 years old and a soldier in the Napoleonic wars.

The kangri burn cancers of the Kashmiris and the kairo burn cancers of the Japanese are well known examples of the influence exerted in the production of skin cancers by the repeated application of heat.

KANGRI BURN CANCER

Since 1881, at the Kashmir Mission Hospital, India, there have been over two thousand cases of kangri burn cancer. During the last 35 years, the surgeons at this hospital have performed 45 operations annually for kangri burn cancer as compared with 10 per annum for other forms of cancer. Ernest F. Neve, senior surgeon at this institution, has written interesting and illuminating accounts of the nature of this neoplasm.

The "kangri" is an earthenware bowl 5 or 6 inches in diameter, surrounded by basket work and surmounted by a wicker handle. It is heated by means of wood-charcoal, and is worn by the poorer class of Kashmiris against the skin under a single, loose garment not unlike a smock. The primary factor in the causation of kangri cancer is heat. Neve has shown by experiment that the temperature to which the skin is exposed is between 150 and 200 degrees F.

The seats of election of the growths are the inner sides of the thighs and the anterior surface of the abdomen above or below the umbilicus. They are never found on the back or on the extensor surface of the limbs. The skin of the abdomen and thighs may exhibit every stage of chronic dermatitis from redness with or without desquamation to thickened patches, warty induration, or even horny outgrowth projecting from the surface. Pigmentation is increased over the distribution of the superficial veins, their course being marked by brown discoloration. Such patients are especially prone to develop epithelioma. The frequency of actual scars from previous burns is noteworthy. It is such a scar which usually forms the nidus of the malignant growth.

The disease is more common in men than in women, because of less continuous use of the basket by the latter. The average age of onset is 55 years. The average duration of life is 15 months from the recognized time of onset of the cancer.

There are three forms of this cancer, all of which are types of squamous cell epithelioma. The most common variety is a circular or oval crateriform ulcer having raised edges and a diameter of about 1½ inches. Another type consists of multiple small ulcerated or excavated areas with little signs of overgrowth. The third variety is a cauliflower excrescence, 3 or 4 inches wide and projecting 1 or 2 inches above the contiguous surface. There is always a septic discharge from the cancer.

More than 50 per cent of the cases, when first seen, show invasion of the regional lymph nodes, particularly the nodes in Scarpa's triangle and along Poupart's ligament when the lesions arise on the limbs. In the operation, which is fairly successful, the lymph nodes are removed first because the primary tumor is septic.

KAIRO BURN CANCER OF THE JAPANESE

The habit of using a portable oven for the maintenance of body warmth is also a cancer hazard among the Japanese. This utensil is a light tin box, 7 inches long, 4 inches high, and 1 inch thick, with a sliding top made of the same material. This flat box is curved on its broad surface to enable it to fit snugly against the contour of the abdomen. Within the box is placed powdered charcoal which is ignited

Fig. 2. Case 1. Appearance on admission.

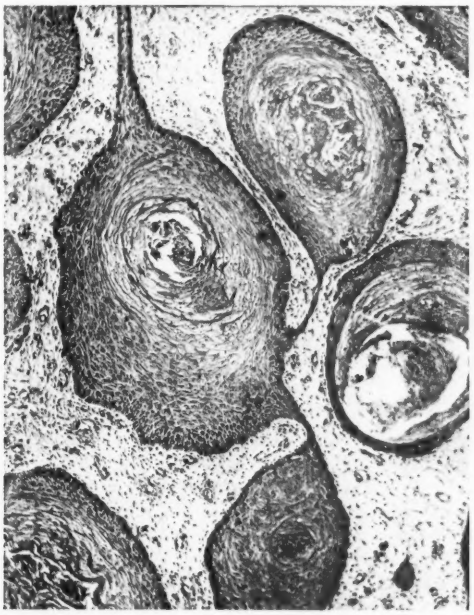

Fig. 3. Case 1. Photomicrograph of squamous carcinoma, Grade II.

by sprinkling hot coals over its surface. The cloth poke or sack enveloping the tin oven is frequently heavily embroidered with designs. It is worn under the kimono and against the shirt and is held in place by a sash around the waist. Heat is generated for at least 3 hours. The kairo is worn more commonly by the older women, particularly when attending temples of worship.

Continued or prolonged exposure of the skin to artificial heat produces an erythematous burn or chronic thermal dermatitis known as *erythema ab igne* (ephelis ignealis) or fire flowers. The mechanism of production of cancer in these areas and the types of lesions are similar in every respect to these features of the kangri burn cancer.

The Etiology of Burn Scar Cancers

Ewing's Postulates

To establish the relation of any cancer to a single trauma, Ewing has formulated a series of postulates which must be fulfilled in each instance. These postulates are equally applicable in the case of carcinomata developing in burn scars, namely:

1. Incontrovertible evidence of the burn, as shown by the wound or the resultant scar.

2. The law of localities, which purports that the cancer must originate within the boundaries of the burned area.

3. The absence of any precursory or similar neoplasm on the site of the burn prior to the development of the cancer. We have observed one case wherein a pigmented nævus was situated in the region of the burn; later a true mælanoma developed in the burn scar. Another interesting occurrence was the development of a neurogenic sarcoma in a burn scar; the patient previously had generalized neuro-fibromatosis. Evidently in these two instances the thermal trauma or the disturbances attendant on infection and healing of the burned skin were sufficient to stimulate these benign neoplasms to malignant proliferation.

4. The histological variety of the cancer must be compatible with the tissues found in thermal wounds and scars, e.g., squamous cell carcinoma in the majority of instances and basal cell epithelioma occasionally in the superficial burns.

Fig. 4. Case 2. Epithelioma originating in burn scar of left temple.

Fig. 5. Case 3. Epithelioma of right temporofrontal region.

5. The interval of time between the date of burning and the onset of the cancer must be proper; this postulate is more important for a single acute trauma than for burns, although on its basis we have classified these tumors into acute wound cancers and chronic scar cancers.

THE CAUSE OF THE BURN

A burn is an injury inflicted on the body by a degree of heat higher than is compatible with healthy action in the part affected. A burn can be caused by any body that radiates much heat. The potentiality of a scar to undergo malignant degeneration and the histological variety of epithelioma resulting are due to the extent of surface area involved and to the depth of the burn, which in turn are related to certain factors, namely: (1) the degree of temperature; (2) the nature of the exciting agent; and (3) its capacity for heat absorption; (4) the duration of contact; (5) the susceptibility of the part acted upon; and (6) the condition of the patient.

TABLE I.—THE CAUSE OF THE BURN

Cause of burn	Acute wound cancer	Chronic scar cancer
1. Flame	1. Squamous cell 1. Basal cell	4. Squamous ca.
2. Alcohol flame		1. Squamous ca.
3. Hot oil or wax	1. Squamous cell 1. Basal cell	1. Squamous ca.
4. Scald		5. Squamous ca.
5. Hot tar		2. Squamous ca.
6. Molten metal		1. Squamous ca. 1. Basal cell ca.
7. Powder explosion		2. Squamous ca.
8. Hot objects	2. Basal cell	2. Basal cell ca.
9. Unknown		3. Squamous ca.

Burns are commonly due to proximity to, or direct contact with, flame or heated solid bodies, superheated air, gas and powder explosions, and inflammable liquids, such as gasoline. Scalds are produced by the action of boiling water, or other liquids, superheated steam, and molten metals. The difference in the effects of burns and scalds is comparable to the distinction between roasting and boiling. The higher the temperature of the burning agent, the more severe injury will result, other conditions being equal.

The content of this report considers only thermal and chemical burns, excluding those cancers developing in skin which has been overirradiated by X-rays or radium.

In general the acute wound cancers which are listed in Table I, and which developed

Fig. 6. Case 5. Epithelioma of scalp, originating in a burn scar.

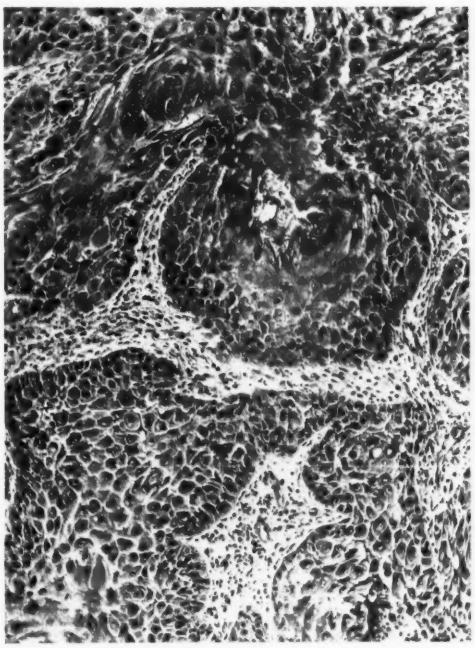

Fig. 7. Case 5. Photomicrograph of squamous carcinoma, Grade II.

within a year of the date of the injury, occurred in instances of quite superficial burns with little surface involvement. The one exception to this rule was in Case 23, in which a burn of moderate severity and extent caused by hot molten wax was complicated by the development of an acute wound squamous cell cancer within a year. Another generalization may be deduced from these data; all the basal cell cancers of scars occur in instances wherein the burn was sufficiently superficial to spare the hair follicles and sweat glands.

At first glance this conclusion seems to contradict our previous conceptions regarding the types of burns produced by the various agents listed in Table I. For example, hot oils were the agents in burns which terminated in two acute wound cancers and one chronic scar cancer. Fluids, such as oil, which boil at higher temperatures than water produce increasingly severe results. The thicker the fluid is, at the same temperature, the greater is its capacity for heat. Moreover, this oleaginous fluid adheres longer and evaporation being slower, the effect is naturally more severe. Burns by hot objects (of which two were by hot cinders or coals) were the causative agents in four instances of basal cell epitheliomata. Ordinarily, as the heat of solid bodies is usually greater than that attained by liquids, except metals in a state of fusion, the former produce very deep burns, in which no vestiges of the previous epithelium and its accessory structures, the hair follicles and sweat and oil glands, remain as possible points of origin for such basal cell epitheliomata. On the contrary, fluids flowing over a large surface cause more extensive though comparatively superficial lesions, yet scalds were provocative of dense hard scars in 5 instances of this series, which resulted in squamous carcinomata at a late period. The explanation for these differences lies in the individual variations and the other factors which influence the development of cancer in scars.

The relative capacity of the substance for heat does not always determine the intensity

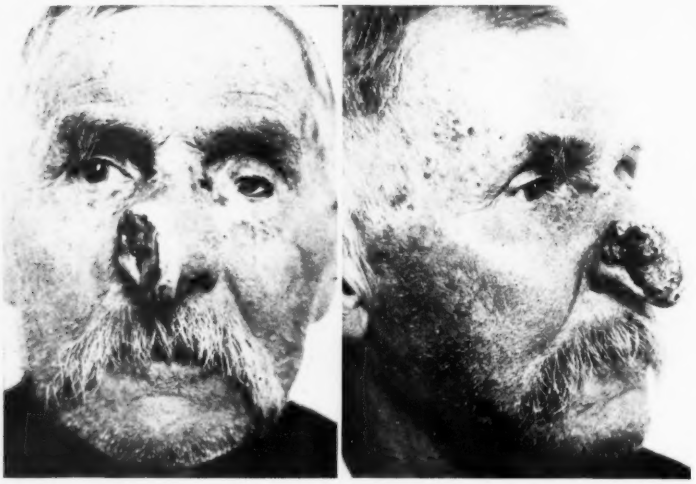

Fig. 8. Case 6. Two epitheliomata of face originating on burn scars. Note the surrounding scars and the acquired epicanthus of the left eye.

of the injury, although in many instances this is true. This apparent paradox can be explained on the assumption that some articles are not only better heat conductors than others, but they cause a more decided destruction of tissue, due to their tenacious surface adherence. This factor is evident in burns by brass (Case 28) and by hot pitch (Cases 12 and 14). In such instances the adherence to the skin involves the tearing away of the superficial portions of the derma in the removal of the burning agent. In view of the carcinogenic influence of tar, one must be cautious in attributing the cancer in the scar to the ordinary factors which induce this development. Tar cancer in the human may develop 30 years after exposure and in experimental animals at least, one application of tar has been known to be sufficient. Findlay used hot tar in his experiments with carcinogenesis, which may invalidate his results in so much as the heat should be considered an accessory factor in the production of cancer.

Fig. 9. Case 7. Ulcerating squamous carcinoma of left postauricular region.

THE SEX INCIDENCE OF CANCER IN BURN SCARS

Of 1,091 squamous carcinomata of the skin studied at the Memorial Hospital, 59 per cent were in males and 41 per cent were in females. Of the 21 squamous carcinomata which occurred in burn scars, 16 (76 per cent) were in males and 5 (24 per cent) were in females. Of 1,374 basal cell carcinomata of the skin studied at the Memorial Hospital, 56.5 per cent were in males and 43.5 per cent were in females. Of the 7 basal cell epitheliomata which occurred in burns or burn scars, 6 (86 per cent) were in

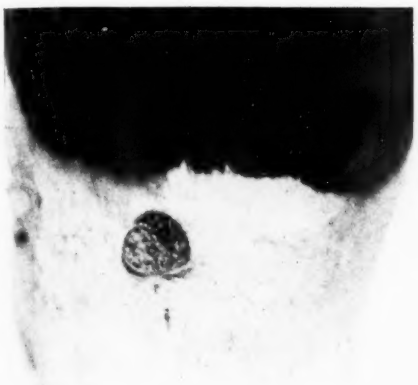

Fig. 10. Case 9. Small epithelioma on an extensive burn scar of the back of the neck. The ears were destroyed by the burn.

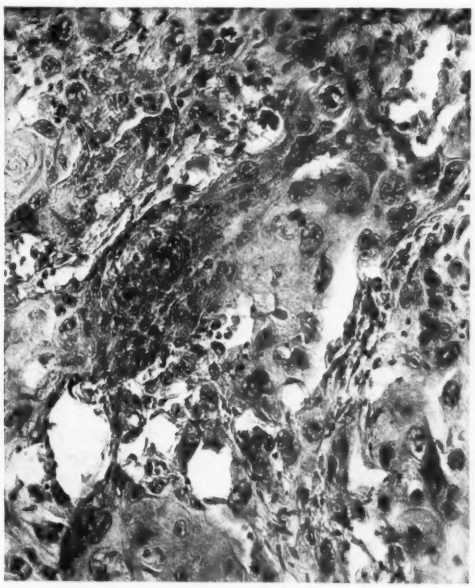

Fig. 11. Case 9. Photomicrograph of squamous carcinoma, Grade II.

males and 1 (14 per cent) was in a female. These figures clearly indicate that the male has a much greater liability to develop cancer in the scars of burns than does the female; this liability moreover exceeds the usual preponderance of male over female in the case of all epitheliomata of the skin.

Few physicians realize that more females than males die of burns, particularly during childhood and old age. In the fourth year of life the relatively high death rate of females begins. The margin increases from 5 to 9 years when more than twice as many girls as boys die of this cause, and there is a more or less pronounced excess in the death rate of females until the age of 35 is reached. It is not until the age of 35 is reached, when very large numbers of men are engaged in industries subjecting them to the hazard of burns and scalds that so many males die from this cause as do females. In later life when fewer men are subject to these risks, women again experience a much higher death rate. Female attire is an important factor in increasing the hazard.

The greater frequency of burns and scalds in females and the infrequency of cancer in the scars of such burns, do not disturb the etiological significance of thermal trauma to scar cancer, although many of these cancers develop in scars of burns which occurred in childhood, when more girls than boys are burned. If the scars of burns are more common in females than in males, then the reason for the preponderance of males who develop cancer in their scars can be found in the more frequent irritation, infection, trauma, and neglect of these scars.

AGE AT ONSET OF CANCER

The average age of 1,091 patients with squamous carcinoma studied in this institution was 58 years; only 7 (0.64 per cent) of these patients were younger than 25 years. The average age of 1,374 patients with basal cell carcinoma studied in this institution was 61 years; only 7 (0.5 per cent) of these patients were younger than 25 years. Of the cancers developing in burn scars and unhealed burns, the chronic scar cancers occurred at the average age of 53.5 years, and the acute wound cancers at the average age of 56 years. The age of the scar is more important than the age of the individual, because this variety of cancer may occur in young people if the scar has been existent for a long time, such as from infancy or childhood. One of the patients in our series (Case 16) was burned at the age of 3½ years and had a squamous cell carcinoma

Fig. 12. Case 10. Ulcerating squamous carcinoma of dorsum of hand and fingers.

develop in the scar 14 years later. In the early report by Hawkins, one of his 2 patients was only 28 years of age. DaCosta reported the occurrence of an enormous squamous carcinoma in a burn scar involving the entire lumbodorsal region of a man aged only 20 years. The average age of the patients with

TABLE II.—AGE INCIDENCE

	Memorial Hospital 28 cases	Other authors 45 cases
A. Age on admission		
Chronic scar cancer	57.2 years	47.5 years
Acute wound cancer	58.0 years	55.0 years
B. Age when burned		
Chronic scar cancer	19.9 years	17.6 years
Acute wound cancer	52.0 years	55.5 years
C. Time interval between burn and onset of cancer		
Chronic scar cancer	32.5 years	30.6 years
Acute wound cancer	0.3 years	0.6 years
D. Chronic scar cancers—number	22	39
Squamous cell type	19	Almost all.
♂=14 ♀=5		
Basal cell type	3	No recorded instance
E. Acute wound cancers—number	6	6
Squamous cell type	2	2
♂=2 ♀=0		
Basal cell type	4	4
♂=3 ♀=1		
F. Time interval between appearance of tumor and admission to clinic		
Chronic scar cancer	3.7 years	
Acute wound cancer	.2 years	
G. Actual total time from onset of cancer until death or present date (3–20–30)		
Chronic scar cancer		
Dead (8)	3.4 years average	
Living (13)	9.5 years average	
	Instances: ½, 3, 4, 4½, 5, 6, 7, 15, 16, 17, and 28 years	
Lost track of (1)		
Acute wound cancer		
Dead (1)	1 year	
Living (5)	5.7 years average	
	Instances: 2, 4, 5½, 8, 9 years	

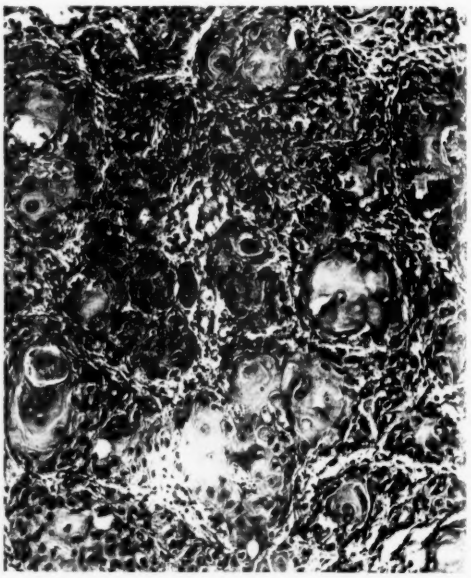

Fig. 13. Case 10. Photomicrograph of squamous carcinoma, Grade II.

carcinomata arising in burn scars and reported by Mason was 51.5 years. The average age or duration of the scars in these same people was 42 years, therefore he concluded that the majority of the burns occurred in childhood.

THE SCAR

Time consumed in healing of wound. In the 6 cases of acute wound cancer, the carcinomata made their recognizable appearance before healing was complete. We have incomplete data concerning the healing of burns which later developed scar cancers; in 9 instances the healing time was ascertained. In 3 of these instances the wound never healed; one developed cancer in 5½ years after the burn (Case 12) and the 2 other patients developed cancer at indefinite periods after the burns. The average time consumed in healing for the 6 other burns was 805 days. Not one burn of these 28 was treated by skin grafting; healing took place by the natural processes of epithelialization from the margins of the wounds and from residual hair follicles and sweat glands when present. Under normal circumstances, this epithelium grows slowly at

Fig. 14. Case 12. Epithelioma of dorsum of right hand.

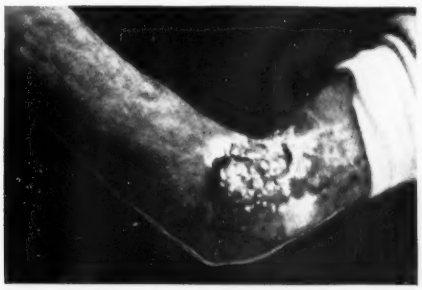

Fig. 15. Case 13. Epithelioma originating in burn scar of elbow.

Fig. 16. Case 14. Epithelioma originating on a burn scar of the right forearm.

the average rate of one-eighth of an inch a week, so if the area of skin lost was of considerable extent, healing would be laborious and tedious. Moreover, infection by pyogenic organisms, a constant concomitant of ungrafted burns, delays the healing process and contributes greatly to the production of dense, fibrotic, avascular scar tissue. Syphilis and anæmia are other factors which interfere with wound healing. Scars of slow formation are much more liable to undergo carcinomatous degeneration than scars quickly formed, as the latter are pliable and soft. The location of the burn sometimes impedes rapid healing, particularly when the axilla, groin, and middle of the back are involved.

Duration of scar before the onset of cancer. It has been stated previously that these forms of cancer can be divided into two separate groups on the basis of time relationship to the development of cancer. The interval between the date of injury and the onset of the cancer was only 0.3 years for the acute wound cancers, whereas in the chronic scar cancers the average age of the scars was 32.5 years. The available data at hand indicate that the patients with chronic scar cancers were burned at the average age of 20 years.

The acute wound cancers of burns are more frequent in older people with atrophic and keratotic skin; the average age of these patients when burned was 52 years. In such instances the thermal trauma is a probable exciting factor to a skin which is already more susceptible to carcinogenic influences, whereas in old scars the cancers are the result of other metagenetic changes and the heat *per se* has no direct bearing on the genesis of the cancers. If heat is not the causative agent in the acute wound cancers of burns, there is the question of possible stimulation by the tissue toxins released by autolysis and heterolysis from the burn eschar; the absorption of these toxins leads to parenchymatous degeneration of the viscera and proliferation of connective tissue. An interesting possibility is presented in a case report by Eichorst; a carcinoma developed in the edge of a duodenal ulcer after burning and metastasized to a dorsal vertebra. This so-called duodenal ulcer of Curling is an occasional complication of extensive burns and its mode of origin is disputed. It is presumably

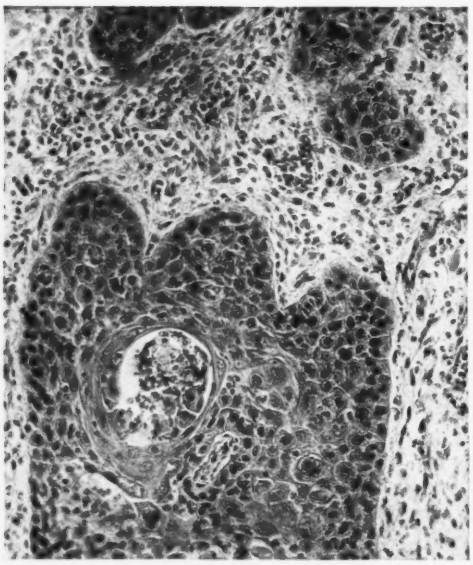

Fig. 17. Case 15. Photomicrograph of squamous carcinoma. Grade II.

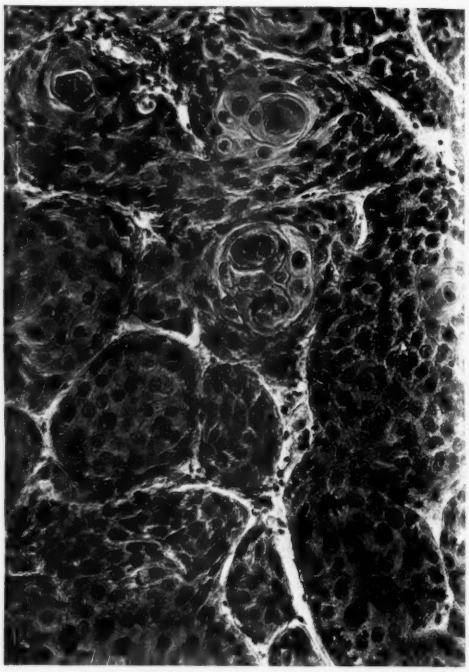

Fig. 18. Case 16. Photomicrograph of an epidermoid carcinoma, which metastasized to the left scapula and right lung.

caused by the excretion of acrid toxins in the bile or by septic embolism in the duodenal wall. Carcinoma of the duodenum is rare and ulcer of the duodenum is common. The toxins resulting from the burn may have had some part in the cancerous transformation of this ulcer in Eichorst's patient.

Acute cancers in burns seem to be infrequent; Stauffer, Bang, Huguenin, and Pickerill have reported cases in point, the cancers appearing within thirty days following the burns.

Relation of the scar to the development of cancer. Scar cancer has been designated by the French as "carcinoma epitheliale cicatrisans." Innumerable cases have been recorded in the literature of carcinoma developing in lupus scars, in scars of sinuses, in scars communicating with necrotic bone as in osteomyelitis, in scars of amputation stumps, in scars of X-ray burns, in scars of animal and insect bites, in vesicovaginal fistula and fistula *in ano*, and even in the scars of operative incisions, although Delbet states that carcinoma never develops in scars of wounds which heal by primary intention. Some œsophageal cancers follow scalds or caustic burns of this viscus (Grandclaude). Among the epitheliomata treated at the Memorial Hospital were 2 squamous carcinomata which developed on scars of a frostbite and of a carbuncle. In Mason's series of 98 scar cancers, 19 were in scars produced by burns. Baasner stated that in 190 collected cases of scar cancer, 33 followed burns, 48 were in fistulas, 39 in leg ulcers, 14 in lupus scars, 12 on calluses, 31 on cicatrices produced by various traumata, and 13 were of miscellaneous origin. Durand collected 90 cases of degenerated scars and noted that 70 of this group were in burn scars. Montpellier and Fabiani comment on the infrequency of epithelioma of the skin and the converse frequency of burns in childhood in the natives of Algiers; they attach an etiological significance to the fact that the 5 cases of cancer of the skin which they report, were epitheliomata which developed on the basis of burn scars.

Bang succeeded in producing experimental scar cancers in 2 mice which had been severely

burned. In 1 mouse, the carcinoma appeared within 4 weeks after the burning. In the other mouse, a papilloma developed in the scar, 1 year and 5 months after burning; this lesion later changed to a true papillary squamous carcinoma.

Goldblatt classifies burns into two classes according to their end-results: those that will heal with scar formation, and those that will heal without scar formation. This method immediately puts into the mind of the surgeon a practical classification in which the expected functional end-result is predominant. Thus under this classification Goldblatt recognizes a type 1 or scar forming, and a type 2 or non-scar forming burn. This classification also, in terms of treatment, tells the surgeon that a type 1 burn will require special treatment to minimize scarring, whereas a type 2 burn will require no thought to the possibility of scar formation and will necessitate no treatment except to relieve the inflammation. Type 1 burn is the only one of significant import in the study of scar cancer.

On the basis of Dupuytren's classification of burn depth, burns of the first degree are not attended by scarring, burns of the second degree produce slight pitting only when the blisters or bullæ injure the stratum germinativum, burns of the third degree produce superficial scars which are not liable to appreciable contraction, and burns of the fourth or fifth degrees tend to cause severe contractural deformities and dense thick scars after healing has occurred. The cicatrices may be small and flat or large and rugous. The neighboring skin may be soft and pliable as in the normal state, or tightly stretched to produce cosmetic disfiguration or contractural deformity. The tight, thick, dense scar is the one most liable to carcinomatous degeneration. Clement, on the contrary, has stated that cancer usually develops on scars of burns of the second or third degree (Dupuytren), in which the skin destruction is not deep. We find the acute cancer of burns, particularly the basal cell type, to originate usually on wounds of this superficial character.

The unique difference of burn scars from the scars of other wounds is that the scar is spread out on the surface and is entirely visible,

Fig. 19. Case 17. Recurrent nodule of epidermoid carcinoma in center of wound of popliteal space.

whereas scars of incisions, punctures, lacerations, etc., are distributed in the depths of the tissues. The process of repair is essentially the same in the two types of wounds, but in the case of burns, the amount of epithelial regeneration is undoubtedly greater.

The scar tissue resulting from a burn undergoes greater contraction than new tissue formed in other circumstances. The tendency of such a scar to contraction continues for many weeks after the completion of cicatrization. Contraction proceeds slowly, painlessly, imperceptibly but irresistibly. As a consequence, the cicatrix puckers the neighboring integument into folds; the scar itself grows thicker and develops irregular knobs or tubercles within its substance. This type of indelible cicatricial tissue is called "inodulaire" by French surgeons and is prone to ulcerate. The amount of scar tissue depends not only on the depth and extent of the burn, but also on the variable susceptibilities of the patients. We emphasize the contractures and tension of scars because it is in such conditions that ulceration is easily provoked.

The diseases of the burn cicatrix are fissures, ulceration, irritability, itching, neuralgia, hypertrophy, and keloidal, epitheliomatous, and calcareous degenerations. The scar is less highly organized than the original integument and as a result is peculiarly liable to ulceration and other degenerative conditions. This conforms to the general law that newly formed and lowly organized structures are much more prone to inflammation and other degenerative processes than are the older and more highly constituted tissues. Virchow, in his treatise on the pathology of tumors, remarked that

Fig. 20. Case 18. Enormous squamous carcinoma originating on a burn scar of the left leg.

cicatrices may be the starting points for certain of the squamous carcinomata. The cicatrix, he wrote, is an incomplete structure and does not reproduce exactly the typical structure of the injured part, an instance where an imperfection of tissue exists as a contributory cause to the development of a tumor.

There is an abnormal relation between the epithelial and connective tissues in every cicatrix which establishes a predisposition to cancer formation in those scars which are accompanied by rhagades, ulcers, fistulas, and similar chronic lesions.

Factors acting on the scar. Scagliola asserted that 10 per cent of his patients had parents who had cancer. He suggested that a hereditary predisposition to the formation of poor scars and even scar cancer might exist. We have no evidence to confirm this opinion. The fact that carcinoma develops in tissue nonexistent at birth sufficiently disproves Cohnheim's theory of embryonal rests and supports Virchow's theory of the irritative origin of scar

Fig. 21. Case 19. Large, fungating, infected squamous carcinoma involving the right buttock, femoral trigone, thigh, inguinal region, and mons veneris.

cancer. There is nothing in the history of scar carcinoma to give any grounds for upsetting the generally accepted theory of the histogenesis of epitheliomata. To Baasner, it seemed probable that the scars which are very slow to heal, afford portals of entry for the causative agent, which can be inoculated only with difficulty, but finds an especially favorable soil for growth in the thin cicatricial epithelium which has been injured in its nutritional relations. Such a theory is supported only by the personal opinion of Baasner.

Scar tissue is poorly vascularized because dense fibrosis obliterates many of the blood vessels; the resultant imperfect nutrition of the scar is responsible for the ease with which ulceration occurs. The dry, thin, and delicate epithelium covering the scar is easily destroyed by trauma, to which it is frequently subjected because of the elevation of the scar. The normal skin is not so readily injured by trauma because it is elastic and because of its ability to glide slightly over the subcutaneous tissues thereby avoiding the full brunt of a blow. In the case of adherent scars, this protective mechanism is lost and the epithelium is abraded by relatively slight injuries. Each successive abrasion, ulceration, or fissure heals with increased difficulty, the quality of the regenerated epithelium is progressively inferior

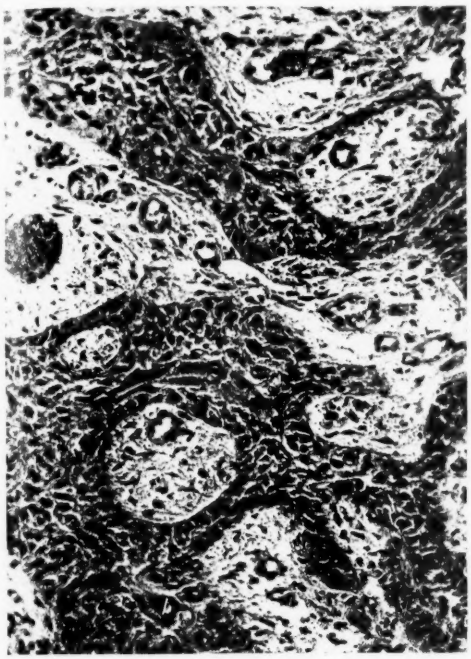

Fig. 22. Case 21. Epithelioma having some of the histological characteristics of a basal cell lesion.

Fig. 23. Case 23. Photomicrograph of a squamous carcinoma, Grade I plus, radioresistant.

and finally the persistent stimulation to the marginal epithelium for repeated growth and repair with constant frustration, may lead to a loss of tissue restraint and eventually cancer.

The development of carcinoma on a cicatrix can be attributed occasionally to the trauma induced by movements of a limb or joint on which the scar is placed. Persistent pruritus in a scar is a dangerous complication because the patient invariably scratches the area and rubs off flakes of keratinized epithelium, leaving small sanguineous points which may coalesce to form an ulcer or may become infected. Acute and chronic traumas, irritation by dirt and clothing, and infection of the scar are the common stimuli to the development of carcinoma in these scars. Prolonged primary or secondary suppuration in the scar is a frequent causative antecedent of carcinoma in this location. In two of our patients (Cases 14 and 28) the stimuli to ulceration of the scars with failure to heal and finally the development of carcinomata, were subsequent burns of the original burn scars.

DISTRIBUTION OF THE SCAR CANCERS

The site of predilection for carcinomata of burn scars are naturally those parts of the head and extremities which are most subject to burns. Is the burn a contributory agent to the creation of a cancer by the production of a scar, or would a cancer have developed in this location anyway? Do the identical locations of these scars and cancers have a causal relationship or is it merely coincidental? These questions probably have been answered correctly by Galard, as follows:

"Certaines conditions traumatiques et en particulier les cicatrices de brûlures sont apparaître les épitheliomes vulgaires à un âge et dans des régions, où l'on n'a guère l'occasion de les rencontrer d'habitude."

In our own experience, we have observed that many of these scar cancers begin in regions where the ordinary epitheliomata of the skin are quite infrequent, as on the arm,

Fig. 24. Case 24. Epithelioma originating in a burn scar of the dorsum of the hand.

elbow, groin, and popliteal space (Cases 13, 14, 16, 17, 19, 20).

Ruchaud lists the distribution of these scar cancers in the order of their frequency as follows: arm, leg, head, and trunk. He found the upper arm affected more often than the forearm and the thigh more often than the leg. The distribution of the 28 cancers in our group is shown in Table III, which can be summarized as follows; head, 10, including 4 of the 6 acute wound cancers; hand, 5; neck, 3; thigh, 3; arm, 2; back, 2; leg, 1; foot, 1; knee, 1. All 5 carcinomata of the hand were situated on the dorsum of this member. The palm of the hand is frequently subjected to superficial contact burns, seldom causing more than vesication; furthermore, palmar burns heal quickly and produce minimal scarring. On the contrary, the dorsum of the hand suffers more severe burns and scalds; the skin texture is of poorer quality and does not heal so readily as the palm; the circulation to the dorsum of the hand is inferior to that of the palm; sharp traumas to scars are more frequent on the dorsum and the metacarpal bones are quite close to the scar. Three of the 5 cancers involved the right hand; the right hand is burned more often than the left and the scars of this location are undoubtedly traumatized more frequently than are similar scars on the left hand. Conversely the left hands of roentgenologists are burned by roentgen-rays and roentgen-ray ulcers and cancers are usually on the dorsum of the left hand.

Pathological Anatomy

Gross pathological anatomy. Cancers developing in burn scars are often multiple if extensive cicatrization exists (Cases 5 and 18). In form they are early distinguished from other epidermoid carcinomata of the skin by the fact that they originate only in the investing epithelium. The carcinomatous degeneration, especially in large ulcers, is often confined to the margins, which begin to crenate and show a warty appearance. There are two clinical forms of this cancer; (1) the flat, indurated, infiltrative, ulcerative carcinomata, and (2) the exophytic, evertent, vegetative, papillary carcinomata. The majority of these neoplasms are the ulcerative variety; the papillary form is infrequent. The papillary carcinomata are often movable and not attached to the deep structures as are the ulcerative carcinomata. The two typical papillary epidermoid carcinomata in this report are Cases 3 and 13. The infiltrating carcinomata invade not only the surrounding scar but also muscles, tendons, and bones (Cases 5, 7, 10, 12, 14, 15, 16, 18, 19, 20). Deep invasion is late and the spread of the tumor by direct growth is often determined by the deep fascial planes. All of the bulky scar cancers are malodorous due to sphacelus and saprophytic infection.

The basal cell epitheliomata arising in superficial scars are small at first and differ in no way from the usual clinical picture of rodent ulcer or of adenoid cystic epithelioma.

Pathological histology. Histologically also, the ulcerative variety is more common than the papillary epitheliomata; furthermore, it is clinically and histologically a more malignant cancer, an assertion which is substantiated by earlier metastases from this sort of lesion. If the burn is deep enough to destroy the corium, then squamous carcinoma is the only histological kind of epithelioma which could originate on the resultant scar, because the hair follicles, sweat glands, and skin accessories *in toto* would be likewise destroyed and the only epithelial structure left would be the epidermis.

By grading these cancers according to malignancy, we found all the epidermoid carcinomata to be squamous cancers, Grades I and II, well differentiated, radioresistant, adult neoplasms. The typical products of keratinization of these carcinomata consist of sterile squamous sheets, where the protoplasm is

changed to keratin or to a substance analogous to keratin. These sheets are end products; they are deprived of nuclei; sometimes this substance is encysted or sequestered in the tissue depths as cornified globules or "pearls." Intercellular fibrils are sometimes visible; mitoses are observed; foreign body giant cells may be present near the globules of keratin. When the bone is invaded, tiny spicules of destroyed bone may be found in the center of the epithelial pearls.

Inflammatory phenomena are present in variable degrees in all these cancers. Lymphocytes prevail around the early lesions, but are obscured later by the polynuclear leucocytes which accompany the inevitable infection. Ewing has tersely stated the rôle infection plays in these chronic ulcerated cancers: "Secondary infection by streptococcus is nearly constant with deep ulcers, may accompany the metastases, greatly influence the course and termination, or may even dominate the clinical picture."

The connective scar tissue forms a protective barrier against dissemination of this kind of cancer. When metastases do occur, they are histologically similar to the primary cancer, hornification, and cysts containing exfoliated scales of keratin being present.

Metastasis

Even when the cancer is of long duration and infiltrates deeply to the bone, the regional lymph nodes are remarkably free from metastases. The time interval between the appearance of the tumor and admission to the clinic of the Memorial Hospital averages 3.7 years for the chronic scar cancers, yet only 5 of these patients had or later developed metastases to the regional lymph nodes (Cases 3, 7, 10, 16, 22). The slow growth and the lateness of dissemination are due to two peculiarities of these cancers; the adult differentiated neoplasms and the character of the environment in a bed of scar tissue. Scar cancer of the dorsum of the hand is especially tardy in metastasizing. Metastasis is by the lymphatics, and the growing edge of the carcinoma must penetrate the barrier of fibrosis presented by the scar before the lymphatic vessels are accessible. The lymphatics in the immediate neighborhood of the scar are largely obliterated by the cicatrix. We believe the propensities of these tumors to grow and metastasize are the same as for other squamous carcinomata of the same histological grade; once these scar cancers get beyond the limits of the enveloping scars, e.g., into muscle which is well vascularized, they will spread as rapidly as any other epidermoid carcinoma.

Squamous carcinoma of any location seldom metastasizes beyond the regional lymph nodes forming the drainage basin for the area affected. Visceral metastases are even more rare, yet they have been reported as occurring from scar cancer by Charcot, Boegehold, Gaucher, Mohr, and Durand. Boegehold's patient had a metastasis to the liver from a primary scar cancer located on the right arm, while Durand's patient, having a carcinoma situated in a burn cicatrix on the knee, disseminated to the iliac, pelvic, and lumbar lymph nodes and to the liver. Mohr reported an instance wherein a squamous carcinoma, developing in a burn scar of the right arm, caused death by histologically verified metastases to the pleura, lungs, heart, and kidneys. In this case he favored the assumption that the long, preceding pre-operative suppuration with its accompanying loss of body fluids, together with infection of the stump and post-operative hæmorrhages, rendered the body incapable of withstanding the colonization of the displaced cancer cells and favored the growth of metastases. The only example of visceral metastasis in our group was in our youngest patient (Case 16) aged 19 years, who developed pulmonary metastasis from a squamous scar cancer of the knee.

Symptomatology

Mode of onset

We have already explained our classification of these neoplasms into two groups on the basis of time of onset: (1) the acute cancer of wounds and (2) the latent cancer of scars. The origin of the latter carcinoma is insidious. We have found that the latent cancers of scars begin in one of five different ways:

1. A small indurated itchy papule appears, which is intimately incorporated in the scar

from which it can not be definitely demarcated. This constitutes the pre-ulcerative stage. The epidermis may be warty, or delicate, dry, and parchment-like, or elevated in grayish-red papillæ, which are sufficiently translucent to show the dilated capillaries in their depths and periphery. In the early stages these nodules may be simple epithelial papillomata, which later become carcinomatous. The greater number, however, are cancer *de novo*. The nodules become humid, increase in size, and ulcerate, after which growth is accelerated by infection (Cases 12 and 22).

2. A diffuse tumefaction of an hypertrophied cicatrix or keloid occurs and becomes quite painful. An ulcer develops and spreads with some rapidity. Sometimes the ulcer is carcinomatous from its inception, but in many instances it is first a simple ulcer which later develops an epithelioma on its margin. This tumor enlarges to include eventually the entire ulcer (Cases 10, 16, and 18).

3. The scar usually loses its integrity before it becomes cancerous. Squamous, scaly, pruritic little plaques appear which are scratched off, leaving tiny sanguineous excoriations. These fuse, resulting in an ulcer caused by a solution of continuity in the scar (Cases 3, 5, and 19).

4. Over scarred joints, indolent fissures may form, which heal, reform, reheal, and finally remain open with firm, resistant, fungoid or infected bases, on which the epithelioma develops (Case 17).

5. The onset of certain of these epitheliomata is by the accidental opening of the scar by trauma. The resultant traumatic ulcer does not heal because of infection and ischæmia. Carcinoma then supervenes (Case 14).

Symptoms. The development of latent cancers in scars is nearly always preceded by marked itching or hyperæsthesia. Functional symptoms are less important than the local manifestations. With the occurrence of an adherent ulcer, a burning sensation begins which may progress to scalding, darting pain. Because of the tenacious infection, the discharge is profuse, ichorous, and foul. Hæmorrhage is not common but may be extremely severe when the carcinomatous ulcer is situated over large vascular channels in the popliteal space, cubitus, and femoral trigone. The invasion of muscles and tendons leads to great functional disability in the later stages. In advanced cases with large suppurating necrotic lesions, toxæmia may result from absorption.

Course. Due to anæmia and environment, the latent cancers of scars follow an unusually slow course as compared with skin cancers arising *de novo*. Those cancers situated on the dorsum of the hand seem to run an especially slow course. Recurrences are usually local. The patient ordinarily remains in good health, until late in the course of the disease when he may be weakened by suppuration, anæmia, or infrequently metastases.

Diagnosis

The characteristic picture of a latent scar cancer is that of a chronic, resistant, indolent ulceration. It slowly enlarges in circumference and increases in depth, presenting glistening, indurated, everted edges. The other varieties are more readily diagnosed. Simple non-malignant ulcers tend to heal spontaneously from time to time. Tuberculous ulcers are rare and occur chiefly in young people; they lack the local qualities of carcinoma; they usually accompany lupus, pulmonary or lymphatic tuberculosis; an acid-fast stain for tubercle bacilli or a biopsy establishes the diagnosis; tuberculous ulcers are more frequently multiple. Lapeyre reported an unusual instance of tuberculosis and squamous carcinoma co-existent in an ulcer arising on an old burn scar. Syphilitic ulcers tend to perforate or penetrate; they have a distinct purplish copper color; they are usually tertiary lesions and respond to specific test therapy; the Wassermann test and a biopsy ordinarily confirm the clinical diagnosis. In some of the ulcerated squamous carcinomata, careful expression causes an extrusion of caseous material resembling comedoes. The early recognition of cancer is imperative in order to effect a cure without mutilating operation; furthermore a correct diagnosis insures proper early treatment.

Prognosis

Despite the slow progress, the absence of disturbing symptoms and the lateness of regional metastases, the prognosis is serious.

TABLE III.—DISTRIBUTION OF CANCERS

Location	Chronic scar cancer								Acute wound cancer							
	Living					Dead			Living					Dead		
	No.	*Irradiation	*Surgery	Present status	Duration of cure	No.	Irradiation	Surgery	No.	Irradiation	Surgery	Present status	Duration of cure	No.	Irradiation	Surgery
Scalp						1	+	o								
Eyelid	1	+	o	No evidence	5 yr.				1	+	o	No evidence				
Cheek	1	+	o	No evidence	2.5 yr.				A	+	o	No evidence	2 yr.			
									B	+	o	No evidence	4 yr.			
Nose	1	+1	+2	No evidence	1 yr.											
Temple	1	+2	+1	No evidence	3.5 yr.	1	+2	+1	1	+	o	No evidence	4 yr.			
Neck	A	+2	+1	No evidence	2 yr.	1	+2	+1								
	B	+	o	No evidence	0.5 yr.											
Arm	A	+1	+2	No evidence	4 yr.											
	B	+1	+2	No evidence	1 yr.											
Dorsum of hand	A	+1	+2	No evidence. T.B.	3 yr.	1	+1	+2	1	+1	+2	No evidence. New cancer on lip	7.5 yr.	1 Died mon ber	+ of ary culos	o pul- tu- is
	B	o	+	No evidence. New cancer on face	16 yr.											
Back	1	+	o	No evidence	3 yr.	1	+	o								
Thigh	1	o	Zn. Cl_2 paste	Cancer present		A	o	+								
						B	+	o								
Knee						1	o	+								
Leg	1	o	+	No evidence	3 yr.											
Foot	1	+1	+2	?	? lost											

*Figures indicate sequence of treatments.

Scar cancers which are located on the face and head are more serious than similar neoplasms on the extremities, because in the latter instance amputation may effect a cure as a last resort. For the scar cancers of the head and face the physician must rely only on irradiation and local excision. The presence of metastases in the regional lymph nodes is the most important prognostic factor; it is of far greater import than the duration of the cancer. The prognosis varies with the selection of operative treatments and the kinds of manipulative measures attempted. The prognosis is modified by the location of the tumor, its fixity, its proximity to blood vessels, the degree of suppuration, and the radiosensitivity. The age of the patient has an influence on the outcome; older people are less tolerant of radical surgical measures, whereas in younger subjects, the epithelioma frequently has greater growth propensities (Case 16).

In Table III, we have summarized the end-results of the cases which have been observed at the Memorial Hospital. Thirteen of the patients with latent scar cancer are living and all but one seem to be free of the disease; 7 (54 per cent) of these patients have been clinically free of cancer for more than 3 years. Eight of the patients who had latent scar cancer are dead; 1 has been lost to further observation. Of the patients with acute wound cancers, 1 died of pulmonary tuberculosis, the 5 remaining subjects are alive and clinically free of disease for an average time of $4\frac{1}{2}$ years after the completion of treatment.

The ultimate prognosis for acute wound cancers is better than for chronic scar cancers although the conditions attending the former

type are more favorable for rapid growth and dissemination of the cancer. The better prognosis of acute wound cancers can be attributed to the superficial character of the average scars in our cases, the small size of the cancers, and the predominance of basal cell types.

Treatment

prophylaxis

There are 6 cardinal points to be emphasized about the prevention of scar cancer in burns: (1) The prevention of the burn; (2) the local treatment of the burn, particularly the successful management of infections; (3) promotion of rapid epithelization; (4) early skin grafting of the burned area; (5) the proper care of the burn scar; and (6) radical excision of the scar at the first indication of degenerative changes, neoplastic, or otherwise.

In so much as the Memorial Hospital is an institution for the treatment of neoplastic diseases, we have little opportunity to institute methods of prophylaxis of cancer in burn scars. The prevention of burns is a subject in itself and has been considered in detail by one of us (G. T. P.) in a recent monograph on burns. A burn has been aptly defined as an infected wound produced by heat. Hence the immediate local treatment of the burn is of paramount importance in avoiding this frequent infection and establishing a granulation bed suitable for skin grafting. Suppuration of the burned area delays healing, stimulates fibrosis, and is instrumental in the production of a thick, renitent scar, the very type which is prone to develop cancer. Suppuration hastens the onset of cancer as the wound healing alternately progresses and is retarded, an unnatural and dangerous stimulation to epithelial proliferation.

In burns of severe degrees, early skin grafting is the most efficient preventive measure for thickened scars, contractural deformities, and cosmetic disfigurations. When skin grafting is delayed, there is formed an unhealthy anæmic granulation tissue, with a scar tissue base. Chronic granulation tissue is the parent of scar tissue. Nature tends to effect a spontaneous cure, but normal epithelization is too slow and should be supplemented by skin grafting. A cancer seldom if ever arises in a scar healed by primary intention; primary wound healing is impossible in burns, but one can approach this condition by early skin grafting. It is very important to employ skin grafting in children, not only for cosmetic betterment and to prevent contractural deformities, but because scars in children are particularly exuberant and hypertrophic and therefore more prone to degenerate later in life. The scar does not grow with the child, consequently, with age it is subjected to increased tension. The existence of the scar from childhood to old age results in prolonged exposure of the scar to carcinogenic influences. None of the 28 patients included in this study had their burns treated by skin grafting. Today, the frequent use of skin grafting by many surgeons who treat a considerable number of burns, will furnish interesting information 20 or 30 years in the future, about the comparative freedom of these grafted wounds from scar cancer.

The thin ribbon Ollier-Thiersch grafts should not be used unless the extent of the burn precludes the employment of whole thickness grafts. The Thiersch grafts do not simulate normal skin; none of the skin accessories, such as hair follicles, sweat and oil glands are present, in consequence of which the grafted area is dry, without oil, and subject to the same degenerations as scar tissue. Cancer has been known to originate on Thiersch-grafted regions. Lyle advocates the occasional employment of Thiersch grafts initially to close the wound, followed after an appropriate interval by full thickness grafts to the same region. If the burn is small and unexposed to view, pinch grafts of the Reverdin or Davis type are sometimes suitable. Burns of the dorsum of the hand are grafted by abdominal bridge grafts or pocket grafts along the lateral aspects of the corresponding thigh.

Every effort should be made to obtain pliable scars over joints, because the flexion and extension of these members tend to provoke ulcers and fissures in tight adherent scars. Therefore, when scar tissue is beginning to form and the burned surface overlies a joint, it is desirable to place the limb in such a position that the motion and integrity of the joint shall not be interfered with by the contraction

of the resulting scar. In a very sick patient, rest and sleep may be so essential that the surgeon should offer comfort even at the expense of this desirable attainment. The position decided upon for each limb should be maintained constantly by the application of light, removable plaster-of-paris splints. The splint should be applied immediately after separation of the eschar and during the healing of the skin graft; it should be fenestrated to facilitate dressings. The splint aids healing, maintains the full extension of the joint, prevents contracture, obviates later undue tension on the scar, insures better movability of the joint, and to some extent eradicates those factors which might lead to degeneration of the scar with ultimate cancer formation.

If the burn, though extensive, has healed spontaneously without the interpolation of skin grafts, the new fresh scar should be treated with this same idea in mind. Splints, adhesive plaster, elastic bands, and extension appliances to prevent contraction should be continuously applied. A hard contracted cicatrix often yields to gentle but constant traction without tearing. If the pressure and traction are continuous, and never violent, supple scars may form and the parts return to almost normal function. New epithelial layers may be ruptured by this method but the results nevertheless are justifiable. The scar can be softened and made more elastic by the continuous application of moist warm packs for a long time. The moisture supplied by boric acid solution must be constant and can be employed concurrently with the exercise of traction. Certain measures, such as diathermy, ionization, and emollient embrocations may be used to reduce fibrosis. Massage is advocated at the earliest moment to restore pliability of the part. Adherent scars are sometimes spontaneously liberated, but they should be aided by massage and hydrotherapeutic measures. In some instances direct pressure by vulcanized india rubber molds to the scar area will be of considerable benefit.

If the scarred skin is tense, poorly nourished, and inclined to ulcerate at the slightest provocation, improvement may be obtained by incisions made at right angles to the direction in which relaxation of the skin is desired. Such incisions, if multiple, should be made parallel to one another and should run in the direction of the chief blood vessels, in order to spare the vascular supply of the scarred area. Some wounds gape 2 or 3 inches in width as a result of this procedure but the defect can be closed later by skin grafting. The original scar quickly assumes a more normal appearance.

All large scars are menaces. All sources of irritation should be avoided. The scar should be treated with a bland oil at times to prevent excessive keratin accumulation. If the scar becomes intractably pruritic, fissured, or ulcerated, or begins to enlarge at a late stage in its history, it is a better plan to excise such a scar before an actual epithelioma develops. Plastic treatment of a scar should seldom be started until the scar has ceased contracting. This is an end point which is difficult to determine and frequently is not reached until a year or more has elapsed since the incurrence of the injury.

The defect following excision of the scar must be filled with a skin graft. For the hand the abdominal bridge graft or the pocket graft of the thigh is suitable. Skin flaps give better results than interpolated grafts of the Wolfe-Krause type, because they have a better blood supply, are less inclined to shrink, and attach themselves more readily to wounds having a scarred base. The sliding flap can seldom be used for this purpose. The transposed flap with the base of the flap at the defect is of service in covering defects on the trunk. Doctor Burton J. Lee, of the Memorial Hospital, has devised a sliding flap to cover axillary defects resulting from the excision of skin in which there was marked degeneration due to irradiation by X-rays or radium. On the head and extremities, we favor the use of pedicled flaps obtained from a neighboring site, if the skin there is available and uninjured by the burn. Otherwise the flap may be transferred as intermittent "jumps" with the forearm as temporary host to the graft. The pedicled flap is thicker than the Wolfe-Krause graft, contains more subcutaneous tissue, and is more viable. One may employ Blair's method, carefully preparing the skin flap, lifting it from its original bed, and then *volte face* by suturing it back again for several days. This

augments the blood supply to the flap and increases the safety of its transfer to the new location. Such delayed transplantation increases the vitality of very thin or long pedicled flaps and should be used as a preliminary measure whenever possible. The application of gentle traction and the discriminate recreation of the skin incisions will generally suffice to release the flap for its transfer.

Before any flap is cut, the blood supply to the area should be thoroughly studied in order to insure an adequate distribution of blood through the pedicle to the flap proper. It is well to remember that skin in the immediate proximity to the burn may be so injured, that its blood supply is impaired to such a degree as to jeopardize the integrity of any flap which might be taken from it. The tubing of pedicled flaps is valuable for three reasons: it improves the vascularity of the flap, by lessening the amount of raw surface exposed, it diminishes the risk of infection, and it renders distant skin available. The flap should be anchored by subcuticular catgut sutures to relieve tension on the skin sutures. Dermal sutures should be for coaptation and not for forceful approximation. No definite time for severance of the pedicle can be advised for all pedicled flaps. Each requires individual surgical judgment. After a period of 6 months following the operation a limited amount of protopathic sensibility can be elicited in the transferred skin; this improves slightly up to 1 year and then becomes stationary.

SURGICAL TREATMENT

Very small epitheliomata may be treated by radium, or if this is not available the actual cautery may suffice. It is just as important to excise ulcers in scars at an early stage even before they become malignant as to treat early ulcers of the tongue and lip. Several of the ulcerated carcinomata included in this study had been curetted by surgeons at other institutions. The curettage of ulcers in scars is fraught with the danger of hastening dissemination of an unsuspected carcinoma. If the ulcer is small and no deep invasion is apparent, then simple excision is carried out; if invasion of the derma has occurred, then more normal tissue must be sacrificed. The operation must always be radical with regard to the carcinoma itself. Superficial carcinomata of the hand may be excised without molesting the subjacent bone. We prefer to give radium a trial opportunity for curing these epitheliomata; if the first attempt is unsuccessful, we believe that it is wiser to do a wide extirpation followed by a skin graft. In this case, we find flaps preferable to free skin transplants for the same reasons as given under our discussion of scar excision.

We have statistical evidence to indicate that local excision of scar cancer is unsuccessful and dangerous. The majority of the local excisions were done before the patients came under our observation. There were at least 14 local excisions done on these 28 scar cancers; 13 of these epitheliomata recurred after the operations, only 1 was cured. There are two explanations for these failures; first, the operations were not radical enough, and second, few of these cancers received pre-operative irradiation.

Amputation may be necessary at times to control hæmorrhage caused by erosion of a large vessel. Other indications for amputation are: (a) when the cancer has invaded so deeply and become so adherent that excision is an impossibility; (b) when the interior of a large articulation such as the knee or ankle is extensively laid open; (c) when large areas of bone are exposed, a condition which results in necrosis; (d) when profound and uncontrollable suppuration of the wound is complicated by fever and a dangerous systemic toxæmia of the patient; (e) when the functional result even after a presumptive local cure would be unsatisfactory, the limb becoming an encumbrance to the possessor. Amputations were performed, for one of the reasons which have been stated, on Cases 8, 11, 12, 14, 15, 18, 20, and 24.

There were 11 patients with latent scar cancer situated on their extremities; of these, 7 eventually had amputations, and 1 of the remaining 4 patients has a recurrent epithelioma of the popliteal space which may necessitate an amputation through the thigh. If the carcinoma is on the ulnar side of the hand, the surgeon may conserve the forefinger and thumb of this hand.

Concerning axillary dissection in cases of carcinoma of the hand Mason states: "Routine axillary dissection is by no means necessary due to the slow growth of the carcinoma; but it is necessary with a process of two or more years duration." Our management is somewhat different. If there are palpable hard lymph nodes in the axilla or groin, the region is treated first by external irradiation. The roentgen-ray is used or 4 gram radium element pack, filter of 1.5 millimeters brass and 0.35 millimeters platinum, a distance of 6 centimeters, and a dosage of 16,000 milligram hours. After the skin reaction has subsided, a complete dissection of the axilla or groin is performed, which is sometimes followed by the implantation of gold filtered radon seeds in the depths of the operative field. The cubital, epitrochlear, or popliteal lymph nodes are seldom involved unless the carcinoma infiltrates deeply enough to drain by way of the deep lymphatics into these lymph nodes.

TREATMENT BY CAUSTICS

Chemical caustics for the treatment of cancer have been employed for centuries. The Egyptians, Indians, and Persians utilized a paste of arsenic and vinegar which was in use until the middle of the fourteenth century. Modifications of the formula were made from time to time. Velpeau in the early part of the nineteenth century treated cancer with a paste (caustique noir) consisting of sulphuric acid. Maisoneuve made use of a paste, the active agent being zinc chloride.

Zinc chloride was not particularly successful at first for it failed to remove the skin over the tumor. For this reason alkaline caustics and mineral acids found more favor in cancer therapy. "Vienna paste" contained potassium hydroxide and quicklime. In this country Willard Parker was enthusiastically treating cancer of the breast and face with caustics.

The first recorded case of cancer originating in a burn scar treated with zinc chloride paste was reported in 1841 by Cæsar Hawkins. Billroth used chemicals in selected cases of cancer but this method fell into disrepute because it had been taken up by charlatans. For the most part the method is applicable to cancer of the breast and skin, or superficial tumors, such as melanoma and neurogenic sarcoma. Fungating infected and inoperable lesions which precluded orthodox surgical measures were considered suitable.

In cases in which the epithelium is intact it is destroyed by the application of potassium hydroxide. The stick is applied with gentle pressure until the subcutaneous fat is reached. A paste made of flour, charcoal, and a saturated solution of zinc chloride is applied. This is allowed to remain for 48 hours. The devitalized tumor tissue is removed with a razor and the paste reapplied. Successive treatments finally reach a base free of tumor tissue. After allowing a granulating base to appear the resulting defect is skin grafted.

The method is primarily a palliative one. Its advantages are that it can be used in infected fields, often destroying foul, ulcerating lesions. The caustic action seals off lymphatics and blood vessels, thus preventing the dissemination of tumor cells and the absorption of toxins. It causes a marked tissue response evidenced by the rich leucocytic infiltration observed in the sections in these cases which have been studied by Ewing.

Two cases in this series were treated in this fashion. The first case, a lesion on the forearm (Case 13), had been treated with radium which failed to control it. The use of zinc chloride was likewise a failure because of the deep invasion of muscle by tumor growth. Continued application of the caustic would have caused serious hæmorrhage resulting from the erosion of the deep arteries. Consequently, an amputation through the shoulder joint was done. This patient is now free of disease for almost 5 years.

The second case (Case 17) was an extensive skin cancer of the popliteal space. This case was treated by Doctor William S. Stone with a brilliant initial result. A recent recurrence has been much more resistant and failed to respond in a satisfactory manner to further chemical therapy. Subsequent interstitial irradiation with radon seems to have controlled the recurrence.

We are not impressed with this method of treatment for cancer developing in burn scars,

but the number of cases treated in this way is too small to draw definite conclusions.

IRRADIATION OF SCAR CANCERS

In the radium treatment of scar cancers the following methods of application were employed:

1. *Tray of radium emanation.* Focal distance of 3 centimeters. Radiating surface of 17.5 square centimeters. Circular form—6.2 centimeters in diameter. Filter of 1 millimeter brass and 0.5 millimeter silver. Therapeutic dose of 3,000 millicurie hours. With filter of 2 millimeters brass and 0.5 millimeter silver. Therapeutic dose of 3,500 millicurie hours.

2. *Square plaque of radium emanation.* Focal distance of 1 centimeter. Radiating surface of 2 square centimeters. Square form—1.8 centimeters square. Filter of 1 millimeter brass and 0.5 millimeter silver. Therapeutic dose of 800 millicurie hours. With filter of 2 millimeters brass and 0.5 millimeter silver. Therapeutic dose of 900 millicurie hours.

3. *Long plaque of radium emanation.* Focal distance of 1 centimeter. Radiating surface of 3¾ square centimeters. Measurement—2.7 centimeters by 1.7 centimeters. Filter of 1 millimeter brass and 0.5 millimeter silver. Therapeutic dose of 1,000 millicurie hours. With filter of 2 millimeters brass and 0.5 millimeter silver. Therapeutic dose of 1,200 millicurie hours.

4. *Round plaque of radium emanction.* Focal distance of 1 centimeter. Radiating surface of 4 square centimeters. Round with a diameter of 4 centimeters. Filter of 1 millimeter brass and 0.5 millimeter silver. Therapeutic dose of 1,200 millicurie hours. With filter of 2 millimeters brass and 0.5 millimeter silver. Therapeutic dose of 1,500 millicurie hours.

5. *Gold-filtered radon seeds for interstitial irradiation.* The filter of these implants was formerly 0.2 millimeter gold; now the filter is 0.3 millimeter gold. The amount of radon in each seed is between 1.5 and 3 millicuries. If the carcinoma is thick, the dosage is computed on the basis of a sphere with the diameter equal to the greatest diameter of the tumor. In such a case a tissue dose of at least 10 skin erythema units should be delivered to the tumor. If the epithelioma is quite flat over the surface of the ulcer, the gold seeds can be placed in triangular arrangement, 1 centimeter between seeds of 1 millicurie each to give a tissue dose of 8 skin erythema units. If 2 millicurie seeds are employed and placed 1½ centimeters apart, the tissue dose would be 11 skin erythema units.

6. *Surface application of radium for the treatment of superficial cancers.* An applicator or mold of dental modelling compound may be made to conform with the dimensions of the cancer. In the substance of this moulage are incorporated small silver tubes containing radon. The distance of the radon from the surface of the tissue is 0.5 centimeter. The filter of silver is 0.5 millimeter. The dose varies from 70 to 95 millicurie hours per square centimeter of radiated surface.

The Regaud technique for the same indication is as follows: The focal distance of the radium from the skin depends on the nature and type of the lesion to be treated, also its depth or height. The distance is obtained by the intervention of a wax (Columbia paste) or dental modelling compound which is transparent to the gamma-rays of radium. If the cancer is small and flat the focal distance may be only 0.6 centimeter, but if it is an elevated or a large lesion, the distance is correspondingly greater as from 1 to 1.5 centimeters. The amount of filtration is 1 millimeter of platinum. The dosage of radium is variable, depending on the size of the lesion. For a small epidermoid carcinoma, such as one 2 square centimeters in area, the dose may be as high as 4½ millicuries destroyed per square centimeter of tumor; but for larger cancers such as one measuring 25 square centimeters in area, the dose is often only 2 millicuries destroyed per square centimeter of tumor.

The opinion is generally held that radium therapy is contra-indicated in the treatment of scar cancers (Roussy, F. M. Johnson, Strauss). Squamous carcinomata of the skin elsewhere are successfully treated by radium. The difficulties attendant on radium therapy of scar cancers are due to at least four reasons: (1) the squamous cancers originating in scars are highly differentiated, adult, radioresistant

neoplasms; (2) due to insufficient blood supply, the normal process of repair or tissue reaction following irradiation is weak or absent in the scar bed; (3) the constant infection of these ulcers interferes with successful irradiation; (4) radionecrosis occurs quickly and with relatively low dosage in scar cancer. When irradiation is unsuccessfully employed, it makes the base of the ulcer more fibrotic than ever and impairs healing. In such an event the irradiation should be followed by wide excision and skin grafting.

Ewing's remarks concerning radioresistance are appropriately applicable to scar cancers: "Carcinomata are resistant in inverse proportion to the degree of anaplasia and in direct proportion to the amount of desmoplastic reaction which they excite. The nature of the tumor bed has much influence on the response to radiation, both favoring and in other cases retarding the response to treatment. It is well known that infected tumors which are the seat of exudative inflammation do not react well to treatment. . . . The infection loosens the surrounding tissues and permits infiltration by invading tumor cells, which more readily penetrate tissue spaces, vessels, and lymphatics. Radiation also tends to accelerate the inflammatory process."

The end-results of treatment as outlined in Table III, show that 4 latent scar cancers and 4 acute wound cancers were cured by irradiation alone. In 2 other instances, radium therapy of latent scar cancers was successful after surgery had failed. Most of these cancers were small and superficial, with one exception (Case 1).

The following 28 cases are fully abstracted. The analysis of these histories has furnished the basis of this study.

CASE REPORTS—ONE TO TWENTY-TWO INCLUSIVE—LATENT SCAR CANCERS

CASE 1. J. L., white male, aged 63 years, reported to the Memorial Hospital July 21, 1927. The patient was 33 years old when he was severely burned on the left side of his face, including the ear, cheek, nose, neck, and chin, and at 58 years the facial scar became ulcerated and would not heal. The ulcer at this time was probably carcinomatous. A time interval of 25 years had elapsed from the date of the burning to the onset of this complication. From 1922 to 1924, he received from 35 to 40 roentgen-ray treatments at another institution; the lesion healed and remained healed for 9 months then broke down again with increased ulceration. Finally, 5 years after the appearance of the neoplastic ulcer he entered the Memorial Hospital.

Physical examination disclosed an irregular, ulcerated lesion, 10 by 4 centimeters in size, involving the left cheek from the region of the temple to below the angle of the mouth. There were no palpable cervical lymph nodes.

Treatment. On August 4, 1927, the patient was given two treatments over this ulcer by a tray of radium emanation. One treatment was over the upper part of the lesion, the other over the lower half. The factors in each exposure were, filter, 2 millimeters brass; distance, 3 centimeters; and dosage, 3,431 millicurie hours. The patient has remained cured for a period of 2½ years. The area was slightly denuded over the malar prominence, but there was no evidence of neoplastic disease. The total duration of time from the onset of this cancer to the present date is 8 years.

Microscopical examination of a biopsy specimen of the tumor showed a squamous carcinoma, Grade I, radioresistant.

CASE 2. E. N., white male, aged 55 years, reported to the Memorial Hospital on July 20, 1926. Twelve years previously, when 43 years old, he was burned by molten metal on the left side of the forehead. The wound never healed and after a short time began to increase in width and acquire a definite elevated margin.

Physical examination showed that beginning above the left eye, and extending upward and backward to the left temple was a superficial ulcer 7 by 3 centimeters in diameter. The edge of this ulcer was raised and everted. There were no palpable adenopathies.

Treatment. In November, 1925, the ulcer was excised by sharp dissection at another hospital. It promptly recurred. On July 27, 1926, a tray of radium emanation was applied to the upper half of the ulcer; the following radiation factors being employed, filter, 2 millimeters brass; distance, 3 centimeters, dosage 2,993, millicurie hours. On July 30, 1926, a similar treatment by a tray of radium emanation was given to the lower half of the ulcer for 3,430 millicurie hours. There was partial regression of the tumor, but not sufficient to justify further attempts at radium therapy. On October 8, 1926, Dr. Hayes E. Martin did a wide cautery excision and exposed the frontal bone. The outer plate was perforated by multiple drill holes which permitted the growth of granulation tissue out of the diploe. In January, 1930, the patient was living with no evidence of recurrent carcinoma. A small area of bone was still exposed.

Microscopical examination of the excised specimen showed a superficial adenoid cystic epithelioma.

CASE 3. A. L., white female, aged 43 years, reported to the Memorial Hospital on November 5,

1917. When the patient was 22 years old, her right temple and forehead were burned by flame. The wound healed rapidly without complication, leaving a scar which extended from the malar eminence and supra-orbital ridge to the pterion. Twelve years after the occurrence of the burn and 10 years before application to the Memorial Hospital, the central part of the scar began to scale and form crusts. She always picked off this scab and soon an ulcer appeared which increased in diameter and became slightly elevated. One year later a definite cauliflower mass was present in this scar.

Physical examination showed on the right frontal region a circular area of uncovered temporofrontal bone measuring 3.5 centimeters in width. Below this defect was a crescentic mass of tumor tissue 5.5 by 2.5 centimeters in surface dimensions and 1.5 centimeters high. There were some small, hard, palpable lymph nodes in the right pre-auricular and parotid areas.

Treatment. Since July, 1917, three cautery excisions of this tumor were attempted at another hospital. The last cauterization exposed the pericranium. On November 6, 1917, the cancer was treated by the application of radium emanation, with a filter of 0.5 millimeter platinum, a focal distance of 1 millimeter, and a dosage of 3,820 millicurie hours. By December, 1917, the carcinoma had regressed almost completely. One small portion of the edge of the lesion appeared to be neoplastic; this was treated with a dosage of 484 millicurie hours on March 5, 1918. On February 15, 1928, the exposed bone seemed to be forming a sequestrum. June 6, 1928, the patient died of paralysis following separation of the sequestrum. The actual total duration from the onset of the cancer to death was 9½ years.

The microscopical diagnosis was papillary epithelioma.

CASE 4. A. W., white male, aged 48 years, reported to the Memorial Hospital on June 15, 1925. Thirty years previously, when he was 18 years old, his right lower eyelid was burned by a hot cinder which burned its way deeply into the substance of the lid where it became imbedded. Twenty-one years after the date of this injury and 9 years before application to this hospital, a thick, ulcerated plaque appeared on the right lower eyelid.

Physical examination showed on the right lower eyelid a deep infiltrating lesion involving the entire inner two-thirds of the lid and extending downward on to the cheek. There were no palpable cervical lymph nodes. The clinical diagnosis was basal cell epithelioma.

Treatment. On June 19, 1925, radium emanation was applied on an applicator of dental modelling compound; the factors were, filter, 0.5 millimeter silver; distance, 0.5 centimeter, dosage, 360 millicurie hours. The lesion disappeared completely. When last seen on July 13, 1928, there was no evidence of disease.

CASE 5. A white male, aged 39 years, reported to the Memorial Hospital on February 10, 1927, complaining of an ulcerated scar on his scalp. When the patient was 7 months old, his scalp was scalded. Healing occurred by second intention, a firm, white, hairless scar being left. Thirty-seven years later (1926), small crusts appeared in the center of the scar; later an ulcer developed in this region.

Physical examination showed that the scar involved the scalp from the region of the anterior fontanelle to the inion posteriorly. It was ovoid, white, firm, and fixed to underlying tissues. The alopecia corresponded to the extent of the scar. Somewhat to the right of the midline of the vertex was an irregular, deep, infiltrating ulcer which had hard edges and was immovably fixed. It measured about 4 by 5 centimeters involving both tables at the vault of the skull. There were no palpable cervical lymph nodes. The blood Wassermann test was negative.

Treatment. In March, 1926, the ulcer had been treated insufficiently by superficial X-irradiation. Later the patient was treated by Dr. Douglas Quick, who used roentgen-rays to produce a marked reduction in the size of this lesion. On February 17, 1927, a tray of radium emanation, filtered by 2 millimeters of brass at a focal distance of 3 centimeters was applied for a dosage of 4,000 millicurie hours. In June, 1927, he had a transient attack of paralysis of his left leg and July 7, 1927, developed hemiplegia of his left arm and left leg. Dr. George H. Hyslop attributed this complication to an involvement of the right temporal area by the invasion of meninges and possibly brain by direct extension of the tumor. By July 27, there was a herniation of the brain and envelopes; when dressing the wound, muscular spasms would occur in the scrotal and pelvic girdle muscles. There was a hypertonic paresis of the left arm and left leg. Spasticity of muscles increased and suggested deep damage, some distance below the cortex. The patient died in September, 1927, 1½ years after the onset of the cancer.

Biopsy showed squamous carcinoma, Grade II, radioresistant.

CASE 6. O. M., a white male, aged 84 years, reported to the Memorial Hospital on April 17, 1920.

During the Civil War, the patient received a gunshot wound of the right elbow which caused some permanent incapacitation. Between the ages of 25 and 35 he was employed in a foundry and during this time he frequently received facial burns from splashes of hot molten metal. In 1879, when he was 33 years old, the inner canthus of the left eye and the right side of the nose were rather severely burned by hot molten metal. These burns healed in a few weeks without the intervention of skin grafting. The resultant scar caused a pseudo-epicanthus of the left eyelids and a stenosis of the left puncta lachrymalis. In 1923, 44 years after the date of the injury an ulcer appeared on the scar of the left inner canthus; this ulcer was treated elsewhere by radium therapy and healed until December, 1928, when it reappeared and was again treated by the same method with apparent success. In September, 1928, another ulcer formed

on the scar on the right side of the nose. This lesion grew rapidly. Radium therapy was given at another hospital without success. This is very likely an instance of multiple epitheliomata arising on the base of a scar.

Physical examination showed in addition to the epicanthus of the left eyelids, an ulcer, 3 centimeters in diameter, involving the right side of the nose as far as the nasal tip. The ulcer had raised indurated edges and extended deeply to involve the cartilage of the nose. There were no palpable cervical lymph nodes.

Treatment. On April 24, 1929, Dr. Douglas Quick elected to do a cautery removal of the nasal growth. The wound healed without difficulty and the patient is now apparently free of neoplastic disease.

Microscopical examination of the excised specimen showed a squamous carcinoma, Grade II, radioresistant. There was some necrosis in the center of the strands.

CASE 7. E. K., white male, aged 53 years, reported to the Memorial Hospital on October 13, 1927, complaining of an ulcer posterior to his left ear. When the patient was 6 years old, he fell in a bonfire and burned the left side of his neck, the edge of the left ear, his left shoulder, and left arm. Healing was slow because the area was extensive and no skin grafting was done. A time interval of 44 years elapsed between the date of the burn and the onset of the present tumor growth. When he was 50 years old an ulcer developed in the scar posterior to the left ear, increasing rapidly in size. In 6 months it was 7 centimeters wide and involved adjoining portions of the scalp and neck. A cautery excision of this ulcer was done at another hospital in May, 1925. The tumor recurred and was treated at least 25 times by electro-cauterization, but the recurrent tumor persisted. One roentgen-ray treatment was given but resulted in but slight effect on the progress of the growth.

Finally, three years after the date of onset of the tumor, the patient applied to the clinic of the Memorial Hospital. At this time a fixed ulcer, measuring 6 by 10 centimeters, was found on the left side of the neck posterior to the ear. The edges of this ulcer were thick and the tumor tissue was 2 centimeters deep. The base of the ulcer was adherent to underlying bone, which was probably involved by the infiltrative growth.

Treatment. For treatment, radium therapy was first elected. A tray of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 3 centimeters, and a dosage of 3,900 millicurie hours was applied on October 20, 1927. Another treatment by a tray of radon with the same physical factors was given for 3,500 millicurie hours on November 10, 1927. On November 22, the lesion had regressed markedly. A round plaque of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 1 centimeter, and a dosage of 1,500 millicurie hours was applied over the edge of the carcinoma on December 16, 1927. A similar treatment was given on December 20, 1927. The carcinoma never regressed completely, necessitating, on March 2, 1928, a cautery excision to include the entire neoplastic and irradiated area. The patient later developed left cervical lymphadenopathies which were probably due to metastases. He died on February 21, 1929, 4½ years after the date of onset of the cancer.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant.

CASE 8. M. R., white male, aged 62 years, reported to the Memorial Hospital on November 19, 1920. When the patient was 42 years old he was burned on the left side of his neck by some hot cinders. The wound healed slowly. Later an ulcer appeared in the scar of this burn. The patient was unable to state the exact date of recognition of this ulcer. It slowly increased in size and depth.

Physical examination showed on the right side of the neck a large, deep ulcer measuring 4 by 4 centimeters. The edges were hard and raised. There were no palpable cervical lymph nodes. The clinical diagnosis was basal cell epithelioma.

Treatment. In July, 1920, the ulcer was excised at another hospital, but it rapidly recurred. On November 19, 1920, radium emanation was applied on an applicator of dental modelling compound; the factors were, filter, 0.5 millimeter silver, distance, 0.5 centimeter, dosage, 259 millicurie hours. On November 26, 1920, a similar treatment was given for a dosage of 276 millicurie hours. On June 3, 1924, Dr. Bradley Coley did a cautery excision of the persistent ulcer, but the neoplasm again recurred. On August 22, 1925, another excision was attempted by Dr. Hayes E. Martin, but the tumor again recurred. On February 12, 1926, 2 gold radon seeds containing a total amount of 3.34 millicuries were implanted in a nodule which was in the scar. On June 1, 1928, another gold radon seed containing 2.99 millicuries was implanted in a small nodule in the scar. When last seen on February 21, 1930, there was no evidence of disease.

Microscopical examination of the excised specimen showed a basal cell epithelioma, markedly affected by irradiation.

CASE 9. T. K., white male, aged 38 years, reported to the Memorial Hospital on January 31, 1930. The patient is by occupation a locomotive engineer. In 1914, when he was 22 years old, an oil immersed switch in his electric locomotive exploded and threw flaming oil over his head and neck. His ears were burned off and there was a deep burn involving the back of the neck and the sides of his head. The wound was not skin grafted and did not heal completely for 2 years. In the latter part of October, 1929, he became aware of a small ulceration in the middle of the scar on the back of his neck. This lesion gradually increased in size during the 3 months preceding his admission to the Memorial Hospital. A time interval of 15 years and 9 months elapsed between the occurrence of the burn and the onset of ulceration. He had had no treatment for this condition.

Physical examination disclosed on the back of the neck a moderately thick, slightly puckered scar which swept around both sides of the neck to involve the stumps of both ears. At a point 1 centimeter to the left of the midline of the back of the neck, was a circular, raised, ulcerated, crusted lesion with rolled-up edges. The center was occupied by soft, yellowish-gray granules of necrotic material. The ulcer measured 2.5 centimeters in both diameters and was 4 millimeters thick. A chain of small, firm, movable pea-sized lymph nodes was felt in the left posterior cervical triangle, but was considered inflammatory in nature.

Treatment. On February 7, 1930, the ulcer was treated by the application of a round plaque of radium emanation; the following factors were used: filter, 3 millimeters brass; distance, 1 centimeter; dosage, 1,600 millicurie hours. On March 7, 1930, there was marked regression of the ulcer. A note by Dr. James Duffy stated that probably all the cancer was destroyed.

Microscopical examination of a biopsy specimen showed a squamous carcinoma, Grade II, radioresistant.

CASE 10. M. B., white female, aged 67 years, applied to the Memorial Hospital on December 9, 1926. When the patient was 3 years old she burned the dorsum of her left hand. One year prior to admission to the Memorial Hospital, the scar became swollen and red; 3 months later an ulcer appeared with elevated edges and firm base. An interval of 63 years elapsed between the occurrence of the burn and the onset of this ulcerated lesion.

On the dorsum of the left hand and dorsum of the third and fourth fingers to the first interphalangeal joint, there was a necrotic ulcer 5½ centimeters in diameter. This ulcer extended into the web, probably involving the tendons. One hard lymph node was palpated in the apex of the left axilla. A radiograph of the chest on March 4, 1929, was negative.

Treatment. Before admission, the patient had received 6 radium and 12 roentgen-ray treatments elsewhere without appreciable effect on the size of the ulcer. She had also received colloidal gold treatments, 27 intravenous injections of 150 drops each. On December 11, 1926, 2 low voltage roentgen-ray treatments were given to the left axilla. On December 23, 1926, a tray of radium emanation, with a filter of 2 millimeters brass and a distance of 3 centimeters was applied for a dosage of 4,000 millicurie hours. There was an immediate response to the use of the radon tray, but the tumor did not regress entirely. The complications of sloughing and infection required an amputation through the distal part of the forearm which was done on February 16, 1927. On October 1, 1928, the left axilla was dissected and the carcinomatous lymph nodes removed. At the same time, 28 millicuries of radon in 14 gold seeds were buried in the axillary wound. A large recurrent tumor appeared in the left axilla which was treated by interstitial irradiation on March 4, 1929, 47 millicuries of radon in 24 gold seeds being used.

In spite of treatment the metastatic cancer in the left axilla continued to grow and infiltrate the surrounding tissues. The patient died in January, 1930, almost 4 years after the date of onset of the tumor.

The original biopsy was reported as a papillary squamous carcinoma. The amputated specimen and the axillary nodes contained squamous carcinoma, Grade II, radioresistant.

CASE 11. W. M., white male, aged 79 years, reported to the Memorial Hospital on May 25, 1927. When he was 20 years of age, his face and the backs of both hands were severely burned by a gunpowder explosion. No skin grafting was done and the wounds healed in 3 months. Forty-four years elapsed without trouble referable to these areas until 1912, when an intractable ulcer developed in the scar on the dorsum of the right hand. After 2 years of unsuccessful local treatment the right hand was amputated. There were no palpable axillary lymph nodes. There has never been any evidence of recurrence of this epithelioma to date, a free interval of 16 years.

Present illness and treatment. In February, 1920, a small keratotic wart was noticed in the scar on the dorsum of the left hand. Although no confirmatory biopsy was taken, this lesion was considered an early squamous carcinoma. This small lesion was treated successfully by the application of radon in a glass filtered bulb. The patient also has a small epithelioma on his facial scar at the present time.

CASE 12. D. W., white male, aged 75 years, reported to the Memorial Hospital on January 20, 1927. He complained of an ulcer on the back of his right hand. Six years previously, when he was 60 years old, he burned the dorsum of his right hand by hot tar. The burned skin never healed completely and 1 year later, a wart appeared on this area, which was treated successfully by cautery. After a free interval of 4⅔ years and 4 months prior to admission to the clinic, the wartlike lesion recurred and grew very rapidly with central ulceration. He experienced no pain.

Examination showed the ulcer to measure 2½ by 4 centimeters and to extend to the base of the index finger and over the second metacarpal bone. There were no palpable axillary lymph nodes. On February 1, 1927, a radiograph of the right hand was negative for bone involvement. On March 30, 1927, a radiograph of the chest showed evidence of chronic pulmonary tuberculosis.

Treatment. Pre-operative irradiation of the cancer was given on January 31, 1927, by the radium emanation pack, at 6 centimeters distance, with a filter of 2 millimeters brass and a dosage of 20,000 millicurie hours. The same treatment was given to the right axilla as a prophylactic measure. On February 7, 1927, the involved index finger, the corresponding metacarpal bone, and the superjacent ulcerated cancer were surgically removed under local anæsthesia. On March 30, 1927, a high voltage roentgen-ray treatment was given to the right axilla as an additional prophylactic procedure. At the

present time there is no evidence of cancer. Over 3½ years have elapsed since the onset of the cancer and 3 years since the successful surgical intervention.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant.

CASE 13. O. G., white male, aged 54 years, applied for treatment at the Memorial Hospital on February 6, 1924. When the patient was 9 years old, he burned the lower half of the left arm, the corresponding elbow, and the upper half of the left forearm by flame. A time interval of 44 years and 7 months elapsed between the date of the burn and the onset of the present tumor growth. Five months had elapsed between the appearance of the tumor and admission to the clinic.

On the anterior and outer aspect of the left elbow was an ulcer with indurated edges, which measured 4 by 6 centimeters. On the outer margin of this ulcer was a cauliflower tumor 4 centimeters wide and 2½ centimeters high. The lesion was surrounded by a thin hairless scar. The left axillary lymph nodes were enlarged but soft. A radiograph of the arm demonstrated that the bones were not involved by the tumor.

Treatment. For treatment, radium therapy was first elected. A tray of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 3 centimeters, and a dosage of 3,000 millicurie hours was applied 5 times in 1924, on February 14, February 26, June 3, June 10, and August 27, for a total dosage of 15,000 millicurie hours. There was marked temporary regression of the tumor, but recurrence soon followed. On November 26, 1925, the lesion was electrocoagulated. On March 19, 1925, the recurrent tumor mass was treated by the application of a caustic paste made of flour, charcoal, and a saturated solution of zinc chloride. This treatment was also ineffectual. Two low voltage roentgen-ray treatments were given to the left axilla, one on July 26, 1925, the other on October 26, 1926. Because all local efforts seemed to be futile, on December 11, 1925, the left arm was disarticulated at the shoulder joint and the left axilla was dissected. At the time of this operation, 16.4 millicuries of radon in gold-filtered seeds were buried in the axilla. Convalescence was uneventful. At present, there is no evidence of disease. Six years have elapsed since the onset of the cancer and 4 years since the disarticulation of the humerus at the shoulder joint.

Histologically, the tumor was a papillary squamous carcinoma, Grade II, radioresistant. The nodes were not involved.

CASE 14. J. T., white male, aged 61 years, reported to the Memorial Hospital on November 14, 1928.

In 1900, when he was 33 years old, both hands, both forearms, and the back of the neck were burned by an explosion of hot tar pitch. The burned area was treated by applications of aristol and powdered starch. No skin grafting was done and the lesion did not heal completely for one year after the occurrence of the accident. Twenty-four years later (1924), the scarred forearm was reburned by contact with a hot radiator. A blister formed, followed by an ulcer which progressively increased in size. Treatment of this ulcer by his local physician consisted of infra-red light, mercurochrome, copper sulphate, diathermy, and electro-dessication. On October 2, 1928, the ulcer was widely excised by another surgeon, who implanted gold-filtered radon seeds into the bed of the operative field. The cancer recurred rapidly and the patient presented himself immediately at the Memorial Hospital, 4 years after the onset of the cancer.

On the left forearm was a smooth, hairless, dry scar; a similar scar was on the back of his neck. There was some contraction of the flexor tendons of the left forearm. On the right forearm was an ulcerated, foul-smelling, necrotic ulcer, serpiginous in outline and measuring 6 by 10 centimeters. The edges were rolled, hard, and elevated; there was a granulation tissue base of the ulcer. The patient suffered severe pain and almost complete loss of function of the arm. There were no palpable axillary lymphadenopathies. The diagnosis was epidermoid carcinoma.

Treatment. Amputation was advised and refused. However, in January, 1929, the arm was amputated at another hospital and at the present time (one year later) there is no evidence of neoplastic disease.

CASE 15. T. T., white male, Italian, aged 56 years, applied to the Memorial Hospital on June 22, 1918. When the patient was 3 years old, he severely scalded his left foot. No skin grafting was done and the wound healed very slowly. A time interval of 52 years elapsed between the date of the burn and the onset of the present tumor growth. One year had elapsed between the appearance of the tumor and admission to the clinic.

On the dorsum of the left foot was an ulcer with everted edges and a diameter of 3 inches. In the right groin were some palpable lymph nodes which were not considered neoplastic. A radiograph on July 6, 1918, showed no evidence of bone destruction; the bones of the foot were osteoporotic due to atrophy of disuse.

Treatment. In January, 1918, the ulcer of the foot and two of the subjacent bones were excised at another hospital. The recurrent ulcer was first treated at the Memorial Hospital by the application of radon on a moulage of dental modelling compound. This treatment was given on July 6, 1918, and consisted of the following factors; distance, 0.5 centimeter, filter, 0.5 millimeter silver, dosage, 3,230 millicurie hours. The disease was not controlled so on August 13, 1918, glass seeds containing 11.5 millicuries of radium emanation were implanted in the lesion. The cancer was very radioresistant and was inseparably fixed to the underlying bone. On November 1, 1918, the left foot was amputated. The stump healed quickly and the patient was without evidence of the disease 6 months later. Since that time he has been lost to further observation.

The microscopical diagnosis was epidermoid carcinoma, Grade II, radioresistant.

CASE 16. E. D., white male, aged 19 years, was referred to the Memorial Hospital on May 11, 1928. When the patient was 3½ years old, his entire right leg from hip to ankle was scalded. Healing was delayed because of the great surface denuded and the failure to employ skin grafting. The resultant scar involved the skin of the right thigh and leg and caused a marked contracture of the knee joint. In 1922, the scar over the knee became fissured and ulcerated. These ulcers would heal and later recur. Finally, 14 years after the occurrence of the burn a persistent ulcer with indurated edges appeared. Enlarged, hard, palpable lymph nodes were found later in the right inguinal region.

Treatment and course. In November, 1927, a dissection of the right inguinal region was done at another hospital, followed in 1 week by an amputation of the right thigh. In May, 1928, a subcutaneous lump was detected in the region of the left scapula. On May 5, 1928, this lump was excised and found to contain metastatic epidermoid carcinoma. At the time of admission to Memorial Hospital, 18 months after the appearance of the tumor, he had hæmoptysis of 3 weeks' duration. There was no evidence of local recurrence at this time, but the right base of the chest was dull to percussion and a radiograph of the chest on May 11, 1928, was positive for pulmonary metastases. The patient died in October, 1928, 2 years after the onset of the cancer. The microscopical diagnosis was squamous carcinoma.

CASE 17. E. S., white male, aged 67 years, reported to the Memorial Hospital on February 25, 1929, with the complaint of a "tumor growth on the back of his left knee." When the patient was 18 years old, a discharge from a Roman candle burned him in the left popliteal space and a large part of the surface of the left thigh. After the burn, he was unable to walk for 9 months. No skin grafting was done and the denuded area did not heal completely for 3 years. Every 3 or 4 years the scar in the popliteal space would break down, become fissured or ulcerate, and then heal. In 1899, such an area in the scar became severely infected and when healing occurred the left leg became so lymphœdematous that he was compelled to wear an elastic stocking. Finally, 46 years after the date of the accident and 3 years prior to admission to the Memorial Hospital, the popliteal scar became ulcerated and would not heal. A fungous growth originated on the edge of this chronic ulcer.

On examination a dense scar was observed to extend from the left groin down the medial aspect of the thigh to involve the left popliteal space. At the lower end of this scar was a fungating, ulcerating tumor, measuring 5 by 8 centimeters. There were no palpable inguinal lymph nodes. Radiographs of the lungs and left knee on February 25, 1929, showed no evidence of pulmonary metastasis but a chronic atrophic osteo-arthritis of the knee.

Treatment. On February 11, 1929, the lesion was given one roentgen-ray treatment at another hospital; the factors were: spark gap, 9 inches; milliamperage, 5; target skin distance, 15 inches; filter, 5 millimeters aluminum; time, 7 minutes. This treatment had no appreciable effect on the size or growth of the tumor, which was a radioresistant type of neoplasm. Dr. William S. Stone treated this cancer by the application of a caustic paste, consisting of a saturated solution of zinc chloride incorporated in flour and powdered charcoal. All local evidence of the carcinoma disappeared and the wound healed completely. After a free interval of 1 year, a recurrent nodule was recently noticed, in February, 1930. This has subsequently disappeared following the treatment by means of radon implants.

The microscopical diagnosis was squamous carcinoma, Grade I, radioresistant.

CASE 18. D. J., a white male, aged 54 years was seen by Drs. William B. and Bradley L. Coley and was admitted to the Fifth Avenue Hospital on October 28, 1927. He complained of the presence of an ulcer in the skin on the posterior aspect of the left lower leg. This patient, while at work, sustained a severe burn over the calf of the left leg, when his overalls were set on fire. This accident occurred 22 years prior to his admission. Healing was quite slow, requiring 7 years for complete epithelization. Two years later ulceration appeared in the center of the scar. For 13 years there has been slow extension of the lesion.

Physical examination showed that the entire skin surface on the posterior aspect of the left calf, extending from the popliteal fossa to within 3 inches of the ankle joint, was replaced by a foul smelling, ulcerating lesion. The base consisted of a papillomatous, red, friable material which bled easily. The edges of the involved area were irregular, raised, and of firm consistence. The area which had been burned was completely transformed into this ulcer. Several enlarged lymph nodes were palpated in the left inguinal space, but clinically they did not appear to be metastatic.

Treatment. After a period of 12 days' rest in the hospital the ulcerating area had been freed of gross infection by the use of Dakin's solution and mercurochrome. On November 10, 1927, a midthigh amputation of the left leg and inguinal dissection was done by Dr. Bradley L. Coley. Postoperative convalescence was uneventful and the patient left the hospital December 29, 1927. The patient has remained free of disease.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant. The lymph nodes were free from metastases.

CASE 19. A. A., white female, aged 47 years, reported to the Memorial Hospital on January 1, 1920. When the patient was 38 years old, she dropped two hot boiled eggs and boiling water on the inner aspect of the right thigh in the region of the femoral trigone. The scald was of moderate severity and healed by epidermatization in 3 months. No skin grafting was done. The scar was thick and hyperkeratotic; the patient continually picked at the

epithelial flakes which formed on the surface of the scar. Finally, 7 years after the date of scalding, an ulcer appeared in the center of this scar. This ulcer had been present for 2 years before the patient applied to the Memorial Hospital.

Physical examination disclosed a large ulcerated, sloughing lesion involving the right thigh from 2 inches above the knee to 1 inch above the inguinal ligament, including the entire medial aspect of the thigh and extending posteriorly and upward to within 1½ inches of the anal orifice, taking in almost the entire buttock on the right side. The ulcer was severely infected and its base was formed of hard, scarred tissue. A sinus 3½ inches long extended upward below the skin of the abdomen. There was marked bilateral contracture of the thighs which were constantly flexed at an angle of 45 degrees with the abdomen. Although this cancerous ulcer was enormous and was suppurating profusely, there were no palpable adenopathies.

Treatment. On February 4, 1929, a treatment of unfiltered low voltage roentgen-rays was given to the involved area; the factors employed were: target skin distance, 15 inches; current, 4 milliamperes; spark gap, 10 inches; time, 10 minutes. There was no demonstrable beneficial effect on the size of the cancer. The location and extent of the disease contra-indicated any surgical interference. The patient died on April 27, 1929, 27 months after the date of onset of the cancer.

Microscopical examination of a biopsy specimen of the tumor revealed a squamous carcinoma, Grade I, radioresistant.

CASE 20. M. H., white female, aged 46 years, applied to the Memorial Hospital on October 5, 1918. In 1881, when the patient was 9 years old, she sustained a severe third degree burn of both buttocks, thighs, and legs. No skin grafting was done and the wound healed very slowly with the formation of dense adherent scars and some contractural deformity. In 1903, the scar on the left leg broke down, became ulcerated, and caused severe pain. This ulcer was excised and the wound skin grafted in 1908. In 1910 the right leg was amputated because of an intractable ulcer which developed on the scar. In 1911, a sore on the right buttock was curetted. In 1912, a sinus developed on the left thigh and buttock and began to discharge necrotic fragments of bone. In 1915, an exploratory incision was made into the depths of this sinus. In July, 1917, the stoma of the sinus began to increase rapidly in size and to assume the characteristics of a malignant ulcer of the Marjolin type. The time interval elapsing between the occurrence of the burn and the onset of the cancer was 37 years. Fifteen months elapsed between the onset of the cancer and admission to the Memorial Hospital.

Physical examination on admission disclosed a large fungating ulcer of the left thigh and buttock. The ulcer measured 10 centimeters by 12 centimeters. There was found no evidence of regional or distant metastases.

Treatment. In February, 1918, several roentgen-ray treatments were given to the ulcer of the left thigh and buttock, but without demonstrable benefit. The previous operations consisting of excision and grafting, amputation of the right leg, curettage of the ulcer, and finally exploratory incision exhausted the possibilities of further surgery, and no treatment of any kind was given at the Memorial Hospital. The patient died on January 17, 1919, 19 months after the date of onset of the tumor.

CASE 21. D. B., white male, aged 50 years, reported to the Memorial Hospital on November 12, 1926. When the patient was 38 years old, his back was burned by flaming alcohol due to an accident in cupping. This burn never healed and the superficial ulcer gradually became obliterated by a slowly growing nodule. During the 12-year interval before admission to the clinic, this tumor had grown to a size of only 1¾ centimeters in diameter.

Physical examination showed on the skin of the back at the level of the iliac crests and slightly to the left of the midline an ulcerated nodular plaque, measuring 1¼ by 1¾ centimeters. The surface of the lesion was elevated above the surrounding skin. The nodule and the adjacent skin were freely movable over the subcutaneous tissues, which indicated the superficial character of the neoplasm.

Treatment. The treatment elected was a surface application of radium. After a biopsy on November 24, 1926, a plaque of radium emanation was applied with a filter of 2 millimeters of brass, a focal distance of 1 centimeter, and a dosage of 1,000 millicurie hours. On February 9, 1927, another radium treatment was given with a plaque for a dosage of 1,200 millicurie hours. The tumor responded readily to irradiation and soon disappeared. Three years have elapsed since this treatment and at the present time there is no evidence of disease.

The microscopical diagnosis by Dr. James Ewing was squamous carcinoma. There were some areas in the biopsy section which resembled adenoid cystic epithelioma.

CASE 22. E. C., a negress, aged 75 years, was first seen at Memorial Hospital on June 25, 1921, complaining of a tender inflamed area in the left scapular region. When she was 6 years old, her left upper arm, left shoulder, left scapular and left posterior thoracic regions were scalded severely. A time interval of 69 years elapsed between the date of the burn and the onset of the present tumor growth. Two months had elapsed between the appearance of the tumor and admission to the clinic. The clinical diagnosis was squamous carcinoma. In April, 1921, small shotty nodules appeared in the center of the scar in the scapular region. These nodules coalesced, increased in size, and finally ulcerated. Definite hard lymph nodes were palpated in the left axilla.

Treatment. On July 7, 1921, a radium treatment was given to the scapular lesion. Silver-filtered tubes of radon (0.5 millimeters silver) were applied on a moulage of dental modelling compound over an area of 4 centimeters, at a distance of 0.5 centimeters,

for 280 millicurie hours. There was some regression in the size of the epithelioma, but a cure was not effected. The patient died on May 12, 1922, 13 months after the assumed date of onset of the cancer.

CASE REPORTS—TWENTY-THREE TO TWENTY-EIGHT INCLUSIVE

ACUTE WOUND CANCERS

CASE 23. F. C., white male, aged 65 years, reported to the Memorial Hospital on February 27, 1924. One year previously he burned the extensor surface of his right arm and the dorsum of his right hand by spilling hot molten wax on these members. The burned region never healed; one small central area remained persistently ulcerated. No skin grafting was done.

Physical examination on admission revealed an irregular ulcerated tumor on the skin of the dorsum of the right hand. This tumor was 2.5 centimeters broad and 1 centimeter thick. With the adjoining skin it was freely movable over the subcutaneous tissues. There were no palpable axillary lymphadenopathies. The patient had the characteristic symptoms of advanced pulmonary tuberculosis, namely: cough, hæmoptysis, asthenia, loss of weight, and night sweats. A radiograph of the chest on March 8, 1924, showed extensive pulmonary tuberculosis in both apices, more marked on the right side.

Treatment. A tray of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 3 centimeters, and a dosage of 3,000 millicurie hours was applied over the lesion on March 4, 1924. When seen on March 20, a good local response was noted but the patient died on April 1, 1924. The actual total duration of time from the onset of the cancer until death was 1 year; however, death was attributed to the pulmonary tuberculosis rather than to the localized epithelioma.

The microscopical diagnosis of a biopsy specimen was squamous carcinoma, Grade I+, radioresistant.

CASE 24. W. F., white male, aged 70 years, came to the Memorial Hospital on July 20, 1922. The dorsum of this patient's left hand had been the seat of chronic eczema following ivy poisoning. Keratotic warts had been cauterized by acids several times before the hand was burned. In March, 1922, 4 months before he reported to the Memorial Hospital, this same area was burned by burning timber. This thermal trauma seemed to be the final inciting factor in the development of epithelioma on this location. The burned area never healed and the superimposed cancer developed gradually and insensibly on this wound.

Physical examination revealed on the dorsum of the left hand over the first metacarpal bone a deep fixed ulcer with heaped-up edges, 1.5 centimeters in width. There were no palpable axillary lymph nodes. A radiograph of the hand on July 21, 1922, showed no evidence of bone destruction.

Treatment. On July 20, 1922, the epithelioma was treated by radium emanation, which was applied on a moulage of dental modelling composed for a dosage of 771 millicurie hours, with a filter of 0.5 millimeters silver, and a focal distance of 0.5 centimeter. The cancer was destroyed completely by this treatment, but the resultant slough of the necrotic tumor tissue left the metacarpal bones exposed. This condition necessitated an amputation, which was done through the forearm on October 25, 1922. At the present time, 8 years after the onset of the cancer, the patient, now 78 years old, has no evidence of his original cancer but is under treatment for a small epidermoid carcinoma of the lower lip.

CASE 25. J. K., white male, aged 35 years, was first seen at Memorial Hospital on April 23, 1928. Seven years previously, when he was 28 years old, he was burned by some flaming sparks on his right cheek. The wound never healed and soon developed a small nodulation in its center. In 1922, this nodule was cauterized by carbon dioxide snow without appreciable effect. In 1923, it was surgically excised, but soon recurred.

Physical examination revealed a superficial ulcer with raised edges situated on a superficial scar of the skin of the right cheek. There were no palpable adenopathies. The clinical diagnosis was basal cell epithelioma.

Treatment. On May 2, 1928, a plaque of radium emanation was applied to the ulcer. The following factors were employed: filter, 2 millimeters brass; distance, 1 centimeter; dosage, 900 millicurie hours. The reaction was a full therapeutic erythema. The tumor disappeared completely and when the patient was seen last on March 13, 1930, there was no evidence of disease.

CASE 26. C. C., white female, aged 55 years, sought treatment at the Memorial Hospital on December 13, 1926. Eighteen months previously, she was burned by hot liquid fat on her left cheek below the eye. The wound never healed and in a very short time an elevated, ulcerated nodule appeared.

Physical examination revealed on the left cheek below the eye, situated on a superficial scar, a small tumor 1¼ by 1¾ centimeters wide and long and 4 millimeters thick. The edges of the ulcerated tumor were elevated and rolled. The clinical diagnosis was basal cell epithelioma.

Treatment. On December 22, 1926, a plaque of radium emanation was applied to the neoplasm. The following factors were employed: filter, 2 millimeters brass; distance, 1 centimeter; dosage, 1,006 millicurie hours. A cure evidently resulted. On September 20, 1929, when last seen there was no evidence of neoplastic disease.

CASE 27. J. McD., white male, aged 66 years, was first seen at the Memorial Hospital on December 15, 1926. One year previously, his left temple was burned by contact with a hot stove. The burn was of a limited area and was superficial in its involvement. The wound healed slowly and 3 months later a nodular tumor appeared in the scar.

Physical examination revealed on the left temple an ulcerated, raised, indurated lesion ¾ by 1½ centimeters in diameter. It was situated on a superficial scar. The clinical diagnosis was basal cell epithelioma.

Treatment. On December 15, 1926, a square plaque of radium emanation was applied to the lesion on the left temple; the following factors were employed: filter, 2 millimeters brass; distance, 1 centimeter; dosage, 750 millicurie hours. The lesion disappeared completely and quickly. On October 15, 1929, when last seen there was no evidence of disease.

CASE 28. A. D., white male, aged 57 years, reported to the Memorial Hospital on November 14, 1928. The patient was employed in a brass factory. He frequently burned the left side of his face and his left eyelids by hot flying brass chips. In April, 1927, a burn by a hot chip left a scar and a definite deformity in the left lower eyelid. On October 23, 1928, another hot chip burned the eyelid in the same location; this chip was buried in the scar and had to be extracted. Three weeks after this last burn and before the wound had healed a small nodule appeared on the eyelid at the site of the injury.

Physical examination showed in the middle third of the left lower eyelid a white, pearly, non-ulcerated tumor. The clinical diagnosis was basal cell epithelioma.

Treatment. On November 23, 1928, a long plaque of radium emanation was applied to this lesion. The following factors were employed: filtration, 2 millimeters brass; distance, 1 centimeter; dosage, 1,000 millicurie hours. The lesion disappeared completely. When last seen on November 21, 1929, there was no evidence of disease.

Six additional cases are reported. These have not been included in the statistical study because we feel that Ewing's postulates have not been completely fulfilled or that the clinical or laboratory data were incomplete.

CASE 29. H. K., a white male, aged 63 years, had a deep, excavated, infected ulcer, 1½ centimeters in diameter, on his right cheek. The edges were firm, indurated, and raised. Histologically, it was a squamous carcinoma, Grade II, radioresistant. Forty years previously, he burned his right cheek by hot cigar ashes. The resultant sensitive scar repeatedly broke down and in attempts to heal, formed crusts. Six weeks prior to admission, a wart-like growth developed on the scar and grew rapidly. Eleven years previously the skin below the inner canthus of the left eye was burned by splashing hot tar. At an indefinite later period an ulcer arose in this scar, but increased in size very slowly. At the time of application to the Memorial Hospital on August 20, 1927, this latter lesion was firm, nodular, and elevated. The epithelioma of the cheek was cured by the application of a round plaque of radium emanation for 1,579 millicurie hours, followed by the interstitial implantation of 9.5 millicuries of radon in gold-filtered seeds. The lesion on the eyelid was cured by the application of a square plaque of radium emanation for 700 millicurie hours, followed by the interstitial implantation of 3.7 millicuries of radon in gold-filtered seeds.

CASE 30. D. M., a white male, aged 63 years, had a superficial irregular, ulcerated epithelioma, 1 by ½ centimeter, on the left lower eyelid. Two years previously he had burned this lid in this location by a splash of molten lead. A cure was effected in 1926, by the application of a square plaque of radium emanation for 650 millicurie hours.

CASE 31. K. D., a white female, aged 38 years, had a small ulcerated epithelioma originating in a well marked scar of the right lower eyelid. When the patient was 28 years old, she received a powder burn of her nose and right eyelids; the epithelioma developed 7 years later after an attempt to remove powder grains from the scar by the application of iodine. A cure was effected by the application of unfiltered radium emanation in a bulb.

CASE 32. M. B., an Irish widow, aged 65 years, had a small epithelioma, 5 by 3 millimeters, on the right side of her nose. This lesion developed on a scar of a burn which she received in childhood, from contact with a hot stove. It was cured by a short application of unfiltered radium emanation in a bulb.

CASE 33. H. E., a white widow, aged 53 years, had an infiltrating, ulcerated squamous carcinoma, 2 by 1½ centimeters, over the right zygoma. One year previously she had burned this area with a curling iron; about 10 months later, an ulcer developed in the scar. A cure was effected in 1925, by the application of a round plaque of radium emanation for 1,602 millicurie hours.

CASE 34. S. A., a white female, aged 33 years, burned her left cheek by hot bacon fat. Four years later a superficial, raised, ulcerated epithelioma 8 by 5 millimeters appeared on the scar. It disappeared in 1926, after the application of 70 millicurie hours of radon in a lightly filtered silver tube.

SUMMARY

A series of cases of carcinoma developing in the scars of burns is reported. These tumors are divided into two groups: the acute wound cancers and the chronic scar cancers.

The potentiality of a scar to undergo malignant degeneration and the histological variety of epithelioma resulting are due to the extent of the surface area involved and to the depth of the burn. The nature of the exciting agent, its capacity for heat absorption and degree of temperature together with the duration of contact are factors which influence such a change.

The age of the scar is more important than the age of the individual. The chronic scar

cancers, in this study, occur at the average age of 53.5 years, while the acute wound cancers develop at 56 years average age. Cancer of burn scars may occur in younger persons if the cicatrix exists from infancy or childhood.

Acute wound cancers develop within a year of the date of injury, occurring in instances of quite superficial burns with little surface involvement. They are more common in older people with atrophic, keratotic skin.

Basal cell cancers developing in burn scars usually occur when the burn is superficial, sparing the hair follicles and sweat glands. This type is noted following thermal injury by hot solids.

Avascular scar tissue results from the slow healing of a burn. Infection in ungrafted burns retards epithelization. Scars slow to heal are more liable to carcinomatous degeneration. Areas which heal rapidly have pliable soft surfaces.

Burns may be classified according to their end-results: those that heal with scar formation and those that are repaired without marked scarring. The surgeon, from clinical experience will recognize which type of burn is to have special treatment in an attempt to minimize scar tissue. The burn which would result in excess scar formation is of significant import in the study and prevention of scar cancer. The tight, thick, dense scar is the one most liable to carcinomatous degeneration, but acute wound cancers, of basal cell type, often originate on wounds of a superficial character. In the contractures following thermal injury and the tension which results, ulceration is easily provoked which may lead to carcinomatous change. Ulceration occurs because newly formed scar tissue is poorly nourished. The fibrosis about blood vessels in the cicatrix prevents an adequate supply of blood to the scar, favoring ischæmic ulceration.

The history of scar carcinoma conforms with the generally accepted theory of the histogenesis of epitheliomata. Fibrosis causes poor nutrition and poor nutrition facilitates ulceration. Trauma easily destroys the delicate epithelium. Healing after each insult is more difficult. The regenerated integument is progressively inferior and persistent stimulation to the marginal epithelium for repeated growth and repair with constant frustration may lead to a loss of tissue restraint and eventually cancer.

The epithelium of adherent scars is abraded by relatively slight injuries, while normal skin is not so readily injured by trauma, because of its elasticity and ability to move over subcutaneous tissues. Likewise the trauma in a cicatrix, due to motion of a joint, may be a source of repeated injuries to the scar, a competent producing factor of cancer in such cases. Persistent pruritus may lead to dangerous complications because the patient scratches the area, rubbing off flakes of keratinized epithelium which leaves small raw spots. These may coalesce to form an ulcer, especially when infected. Prolonged suppuration may be a frequent causative antecedent of cancer in these locations.

Cancer in burn scars occurs in those parts of the head and extremities most subject to burns. Many of the carcinomata personally observed have developed in regions where ordinarily epitheliomata are infrequent—arm, elbow, groin, and popliteal space.

When carcinomatous degeneration begins it is often confined to the margins of the ulcer. There are two forms of this cancer: (1) the flat indurated, infiltrating, ulcerating carcinomata, and (2) the papillary carcinoma. The latter form is infrequent. The former is invasive late in its course. Histologically and clinically, the ulcerative variety is a more malignant cancer. This form metastasizes earlier. All the epidermoid carcinomata in this study were squamous cancers, Grades I and II, well differentiated and radioresistant. Because they are adult, differentiated neoplasms arising in areas of scar tissue, growth is slow and dissemination is late. Once the cancer is beyond the cicatrix it may invade or metastasize more readily. Visceral metastases are rare; only one of our cases developed secondary deposits which occurred in the lungs.

As elsewhere in the body, the early recognition of scar cancer is imperative if a satisfactory result is to be obtained. Late diagnoses may require mutilating operations in an attempt to effect a cure. Scar cancers on the

face and head are more serious than similar neoplasms arising on the extremities. Radical surgery in the former group is precluded, while an amputation of a limb may effect a cure as a last resort in the latter group. The presence of invaded lymph nodes is of serious prognostic import, much more so than the duration of the disease. The prognosis is modified by the location of the tumor, its fixity, its proximity to blood vessels, the degree of infection, and the radiosensitivity. The age of the patient may influence the end-result, for old people will not readily tolerate radical surgical procedures while the disease in younger individuals has greater growth propensities. The ultimate prognosis for acute wound cancers is better than for chronic scar cancers, although the conditions attending the former type are more favorable for rapid growth and dissemination. This more favorable outcome may be attributed to the superficial character of the scars, the small size of the lesions, and the predominance of basal cell types, which are much more amenable to radiation therapy.

A plea is made for adequate, satisfactory, and aggressive treatment of burns. Here is a definite field for cancer prophylaxis. Burns should be prevented, local treatment should be instituted to prevent infection of the burned area, once the damage is done. The burn scar should be properly cared for and measures adopted which will promote rapid epithelization. Early skin grafting should be employed where repair is slow or in cases in which the surgeon feels an excess of scar tissue will develop. Lastly, a radical excision of the scar should be performed when persistent ulceration is present or degenerative changes appear.

In burns of a severe degree skin grafting is the most efficient preventive measure. When skin grafting is delayed, unhealthy granulations with a scar tissue base develop. It is important to employ skin grafting in the burns sustained by children, not only for cosmetic and functional results but because the exuberant scars which form in young individuals are more prone to degenerate later in life. The types of skin grafts to be used will depend upon the severity, extent, and location of the burn.

Scars which have formed, especially large ones, are menaces. They must be safeguarded against irritation and trauma. If dry they should be occasionally treated with a bland oil or ointment to prevent excessive keratin accumulation.

Radiation therapy, especially the use of heavily filtered radium at a distance, should be the first form of treatment for these epitheliomata. The small lesions, and particularly the basal cell lesions, will usually disappear after adequate irradiation. Radiation failures may be due to the type of squamous cancer occurring in burn scars which is a highly differentiated adult neoplasm. These epitheliomata have inadequate blood supplies and the tissue reaction and process of repair are weak or absent in the scar bed. Infection which is present interferes with successful irradiation. Four latent scar cancers and four acute wound cancers were cured by irradiation alone, and in two other instances this form of therapy was adequate after surgery had failed. If radium is not available, a wide local excision or destruction with the actual cautery may suffice. Curettage is inadvisable.

If the lesions are radioresistant, surgical intervention becomes necessary and the magnitude of the procedure will depend upon the location and extent of the lesion. Local excision of well developed scar cancer is unsuccessful and dangerous. The failure in such instances is due to the fact that the operations were not radical enough and that few of the cancers received pre-operative irradiation.

This study was made possible by the kindness of Dr. Douglas Quick, Dr. William S. Stone, and Drs. William B. and Bradley L. Coley, who allowed us to incorporate many of the case histories in addition to our own.

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CARCINOMA OF THE RECTUM

A Study of Three Hundred Three Cases

E. PARKER HAYDEN, M.D., F.A.C.S., and WILLIAM M. SHEDDEN, M.D., F.A.C.S., Boston

CANCER of the rectum and sigmoid, which comprises about three-fourths of the malignancy of the intestinal tract and which has been variously estimated as including between four and sixteen per cent of all cancers, has been the subject of investigation for many years. It was with the idea of throwing a little more light on the course of the disease and of emphasizing the indications for radical or palliative therapy, that the authors were prompted to undertake the study of the cases of this condition seen at the Collis P. Huntington Memorial Hospital.

During the last few years, numerous articles have been written which have emphasized some particular phase of treatment, such as operation or radium therapy. We, therefore, deemed it worth while to gather together for review a large number of cases treated in various ways and to record their progress as far as is possible, taking the cases consecutively and classifying them.

Between May, 1912, and January, 1928, 303 patients entered the hospital with a clinical diagnosis of carcinoma of the rectum. All these cases have been included in our paper, but no case has been accepted as a cure unless a pathological examination was made of the tissue removed at operation or at biopsy.

In reviewing the records, it soon became evident that we should emphasize two factors influencing our decision as to treatment: (1) whether there was previous operative therapy; and, if employed, whether it was radical or palliative; (2) our clinical impression as to whether the case was relatively favorable or unfavorable for cure or length of life.

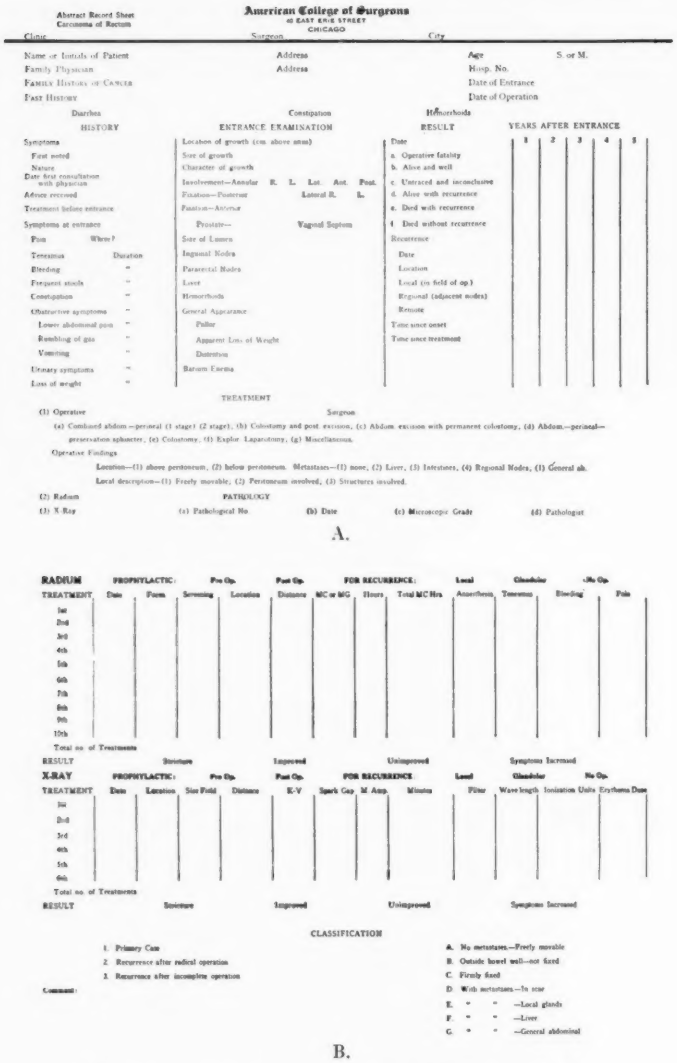
To that end we devised an abstract record sheet modeled on those of the American College of Surgeons already in use for tabulating cases of carcinoma of the breast, cervix, and buccal cavity. We then offered it to the American College of Surgeons, feeling that if the various clinics studying cancer of the rectum would record their cases on this type of card, it would greatly simplify the total grouping of the disease throughout the country. This card has been accepted by the College.

Under the heading, "Classification," (Fig. 1, B) it will be noted that the cases fall into the two main groups suggested. Under the subheadings, 1, 2, and 3, we have placed respectively the cases that have had no previous operative therapy, radical therapy, or palliative therapy; and under the letters A to G we have attempted to indicate the criteria for gauging their prognosis. We intend to elaborate more fully upon our conception of the terms "radical" and "palliative" later in the main body of the paper, for we have very definite ideas as to what form of therapy will give a patient the best chance of cure. It was decided not to make a separate classification for the cases that had radium, X-ray, or other non-operative therapy *previous* to entering the hospital, as there were too few of these cases to warrant grouping. Furthermore, we were unable to obtain exact data as to technique of application of the radiation. This subject we will, however, take up later under the heading, "Treatment before Entrance."

Decision as to whether a case shall be placed in group A or B is, of course, difficult, for it is sometimes almost impossible to estimate the depth of penetration of a growth through the bowel wall. Also, we wish to emphasize that in cases placed in group C, the prognosis varies tremendously according to whether the fixation of the bowel is due to extension of growth into perirectal tissue or to inflammatory changes.

ETIOLOGY

In some of these cases there is a history of previous chronic inflammatory lesions, but the number is not convincing or the connections at all apparent. We agree with Daniel F. Jones who says "It is useless to state that



Abstract Record Sheet
Carcinoma of Rectum

American College of Surgeons
40 EAST ERIE STREET
CHICAGO

Clinic ____ Surgeon ____ City ____

Name or Initials of Patient ____ Address ____ Age ____ S. or M.
Family Physician ____ Address ____ Hosp. No. ____
Family History of Cancer ____ Date of Entrance ____
Past History ____ Date of Operation ____

HISTORY

Diarrhea ____ Constipation ____ Hemorrhoids ____

Symptoms
First noted
Nature
Date first consultation with physician
Advice received
Treatment before entrance
Symptoms at entrance
Pain ____ Where?
Tenesmus ____ Duration
Bleeding ____ "
Frequent stools ____ "
Constipation ____ "
Obstructive symptoms ____ "
Lower abdominal pain ____ "
Rumbling of gas ____ "
Vomiting ____ "
Urinary symptoms ____ "
Loss of weight ____ "

ENTRANCE EXAMINATION

Location of growth (cm. above anus)
Size of growth
Character of growth
Involvement—Annular R. L. Ant. Post.
Fixation—Posterior Lateral R. L.
Fixation—Anterior
Prostate— Vaginal Septum
Size of Lumen
Inguinal Nodes
Paracecal Nodes
Liver
Hemorrhoids
General Appearance
Pallor
Apparent Loss of Weight
Distention
Barium Enema

RESULT

Date
a. Operative fatality
b. Alive and well
c. Untraced and inconclusive
d. Alive with recurrence
e. Died with recurrence
f. Died without recurrence
Recurrence
Date
Location
Local (in field of op.)
Regional (adjacent nodes)
Remote
Time since onset
Time since treatment

YEARS AFTER ENTRANCE 1 2 3 4 5

TREATMENT

(1) Operative ____ Surgeon ____

(a) Combined abdom.—perineal (1 stage) (2 stage), (b) Colostomy and post. excision, (c) Abdom. excision with permanent colostomy, (d) Abdom.—perineal—preservation sphincter, (e) Colostomy, (f) Explor. Laparotomy, (g) Miscellaneous.

Operative Findings

Location—(1) above peritoneum, (2) below peritoneum. Metastases—(1) none, (2) Liver, (3) Intestines, (4) Regional Nodes, (5) General nb.

Local description—(1) Freely movable, (2) Peritoneum involved, (3) Structures involved.

(2) Radium
(3) X-Ray

PATHOLOGY

(a) Pathological No. (b) Date (c) Microscopic Grade (d) Pathologist

A.

RADIUM — PROPHYLACTIC: Pre Op. Post Op. FOR RECURRENCE: Local Glandular No Op.

TREATMENT | Date | Form | Screening | Location | Distance | MC or MG | Hours | Total MC Hrs | Anaesthesia | Tenesmus | Bleeding | Pain

1st
2nd
3rd
4th
5th
6th
7th
8th
9th
10th

Total no. of Treatments

RESULT Stricture Improved Unimproved Symptoms Increased

X-RAY — PROPHYLACTIC: Pre Op. Post Op. FOR RECURRENCE: Local Glandular No Op.

TREATMENT | Date | Location | Size Field | Distance | K-V | Spark Gap | M. Amp. | Minutes | Filter | Wave length | Ionization Units | Erythema Dose

1st
2nd
3rd
4th
5th
6th

Total no. of Treatments

RESULT Stricture Improved Unimproved Symptoms Increased

CLASSIFICATION

1. Primary Case
2. Recurrence after radical operation
3. Recurrence after incomplete operation

A. No metastases.—Freely movable
B. Outside bowel wall—not fixed
C. Firmly fixed
D. With metastases.—In zone
E. " " —Local glands
F. " " —Liver
G. " " —General abdominal

Comment:

B.

Fig. 1. Face, A, and reverse side, B, of abstract record sheet.

cancer starts in hæmorrhoids, fistulæ, ulcerations and strictures of the rectum, for there are so few cases in which it can be proved, the statement has little weight." As a matter of fact, there is a very small proportion of the cases in which a history of any of these conditions, with the exception of hæmorrhoids, ever having existed can be obtained and, in the case of hæmorrhoids, it is a fact that so many people possess them in some degree that the later development of cancer in a few would seem to be mere coincidence. Also, when cancer does develop, it occurs much more commonly some distance above the hæmorrhoidal area. In this series, only 18 per cent were located in or close to this region. Con-

TABLE I.—PRE-EXISTING RECTAL PATHOLOGY

	Occurrence	
	Cases	per cent
Hæmorrhoids	89	29
Constipation	90	29
Diarrhœa	65	21
Fistula	6	2
Stricture	1	.33

TABLE II.—AGES AND SEX

Age in years	Males	Females
10 to 20	0	1
21 to 30	2	1
31 to 40	8	8
41 to 50	37	24
51 to 60	55	41
61 to 70	53	24
71 to 80	22	16
81 to 90	0	4
91 to 100	0	1
Not given	2	4
Total	179	124

The average age of males was 57 years; no age given in 2 cases. The average age of females was 49 years; no age given in 4 cases. Total number of cases, 303.

stipation is so common an ailment that it can hardly be considered as an important etiological factor, though it may well play some part in causing irritation of adenomatous areas.

Just as in cancer of the skin and buccal mucous membrane, we recognize keratoses and leucoplakia as being definitely precancerous lesions, so in the rectum adenomatous polyps constitute the most dangerous predisposing factor in the development of adenocarcinoma here. Mummery, Dukes, Jones, Rankin, Yeomans, and others have written convincingly on this point. We have had no opportunity actually to observe this transition in a particular polyp in any case, and the patients in this series were not under observation before the growth itself was detected. Adenomata do occur in the areas most frequently involved in cancer and by their structure could, and undoubtedly do, undergo malignant degeneration. (See under "Pathology.") That cancer and polyps may co-exist in the same area is a matter of common observation, and is clearly shown in Figure 2. Case 116 in our series presented similar pathology. Yeomans quotes two series, totaling 61 cases, of Doering and Soper, in which adenocarcinoma developed in 26 cases. Tuttle reported 8 cases of multiple polyposis with adenocarcinoma in 5 of them. Mummery cites a case in which 3 entirely separate areas

Fig. 2. Annular carcinoma superimposed on a multiple polyposis of the rectum and sigmoid (a case operated on by Dr. Edward P. Richardson).

of carcinoma occurred in the rectum. One of us (W.M.S.) recently removed a rectum with two distinct and separate areas of carcinoma co-existing with multiple polyps.

AGE

Our figures agree with those of other clinics which show the greatest number of cases in the fifth decade of life. We had, however, in our hospital a girl of 18 years with a clinical diagnosis of carcinoma of the rectum. No biopsy was done, but she died with what was apparently carcinoma of the rectum, and her death certificate was signed with that diagnosis.

The youngest female on whom we have a definite pathological report was 34 years.

The youngest male case with a definitely proved diagnosis was 26 years. Allingham, quoted by Mechling, reports a case of a boy of 13 years, and Pennington mentions 3 cases at the age of 11 years.

We have 1 female of 92 years with a clinical diagnosis of carcinoma of the rectum, another of 81 years with a definite pathological report of carcinoma, and a man of 83 years also with a definite report. (See Table II.)

SEX

There were 179 males and 124 females. (See Table II.)

FAMILY HISTORY

Only 12 cases, or 7 per cent, of 177 (i.e., the cases about which we have known data) gave a history of cancer in the immediate family.

TABLE III.—FAMILY HISTORY OF CANCER

	Per cent	Cases
Negative to carcinoma	93	165
One parent died of carcinoma in 11 cases; other members of family were affected in 1 case.		
Total	7	12
Region affected		
Gastro-intestinal tract—rectum, 2; stomach, 4; intestine, 4		10
Other regions		2
Number of cases with known data		177
Number of cases with no data		126
Total number of cases		303

TABLE IV.—DEGREE OF MALIGNANCY

	Grade	No. Cases	Per cent
Epidermoid carcinoma	1	3	3
Epidermoid carcinoma	2	5	5
Epidermoid carcinoma	3	1	1
Malignant adenoma	.....	57	57
Adenocarcinoma	1	18	18
Adenocarcinoma	2	10	10
Adenocarcinoma	3	2	2
Colloid	4	1	1
Malignant adenoma, and adenocarcinoma	1	3	3
Adenocarcinoma	1 and 2	1	1
Total		101	

To date there is too little definite material on hand regarding heredity as a factor in this disease for us to do more than present this table of figures. (See Table III.)

Mummery, quoted by Pennington, gives a history of three families, the members of which had adenomatosis for several generations. A large number of them died of cancer of the rectum, many of the patients at a comparatively early age.

There were, for instance, 7 between the ages of 27 and 54 years. It is felt by most of those who have investigated family incidence that the frequency of carcinoma in the families studied is no greater than that in the populace at large.

PATHOLOGY

By far the greater number of malignant tumors of the rectum are glandular carcinomata. Next in frequency, but far behind in numbers, come the squamous cell or epidermoid carcinomata. Sarcoma and lymphoma are met with rarely. We have found no sarcomata but have seen two proved lymphomata since this series was closed. There are positive pathological reports on only 143 cases—or 47 per cent of the entire series. In the earlier years, specimens were not excised as frequently for diagnosis, probably because of the fear of accelerating spread of the disease by so doing. The feeling, of late, has been that biopsy of a growth, by definitely establishing the diagnosis and permitting a grading of the degree of malignancy, has advantages that more than outweigh any possible stimulation of the growth by the cutting; for cauliflower-like, ulcerated, nodular, fixed tumors of the rectum are not always carcinomata, as is illustrated by the following case history from our series: A man of 36 was operated upon with the diagnosis of cancer of the rectum. It was decided on opening the abdomen that the tumor was inoperable as it was firmly fixed in the pelvis. A colostomy was performed and he was treated with radium. To the surprise of all the large tumor disappeared. The original section of the tumor was reviewed microscopically. Dr. J. Homer Wright then made the diagnosis of angiomatous polyposis. It is now 5 years since his laparotomy and so far there has been no sign of recurrence. Obviously the fixation was inflammatory.

Our tumors, in so far as slides are at present available (101 cases), have been carefully grouped, as to degree of malignancy, based on a classification slightly modified from that of Broders, as shown in Table IV.

Warren groups as "malignant adenomata" those tumors showing large glandular structures, similar in size and appearance to benign adenomata, and undoubtedly derived therefrom. He recognizes, also, that in some cases where section from the surface of a tumor shows "malignant adenoma," a section nearer the base may show the typical small glandular structure of adenocarcinoma. Three cases in our series illustrate this point.

The malignant adenomata are usually low grade, while the adenocarcinomata show more variation. Of the malignant adenomata, 6 were on the borderline of simple adenomatous polyps.

The value of this classification lies, to a large extent, in its prognostic importance. Under similar methods of treatment one expects the least malignant cases to survive

TABLE V.—SYMPTOMS FIRST NOTICED BY THE PATIENT

	Per cent	No. cases
Common symptoms		
Bleeding alone	12	39
Bleeding and diarrhœa	4	14
Bleeding and constipation	3	10
Bleeding, constipation, pain	2	8
Bleeding, diarrhœa, pain	1	5
Total bleeding	22	76
Rectal pain alone	17	52
Rectal pain and other symptoms	12	37
Tenesmus and other symptoms	4	12
Total rectal pain	33	101
Constipation alone	4	12
Constipation and other symptoms	13	40
Total constipation	17	52
Diarrhœa alone	2	6
Mucus in combination	3	11
Back pain and other symptoms	5	16
Uncommon symptoms		
Mucus alone		1
Pain in penis with other symptoms		1
Back pain alone		2
Incontinence of feces in combination		6
Urinary frequency in combination		3
Dysuria in combination		1
Pruritus alone		2
Pruritus combined		1
Abdominal pain alone		1
Abdominal pain in combination		2
Mass in groin alone		1
Mass at anus alone		1
Abdominal mass alone		1
Vaginal bleeding in combination		2
Ulcer at anus		1
Indigestion in combination		1
Fistula in combination		1

TABLE VI.—SYMPTOMS DEVELOPING DURING PRESENT ILLNESS

	Per cent	Cases
Blood	65	197
Pain (rectal)	61	187
Loss of weight	53	163
Constipation	50	152
Tenesmus	15	47
Frequent stools	15	47
Flatus	7	22
Abdominal pain	5	16
Urinary—		
Dysuria	less than 1	1
Frequency	less than 1	2
Nocturia	less than 1	3
Retention	less than 1	2
Difficulty starting	less than 1	2
"Bladder trouble"	less than 1	1
Total urinary	4	11
Loose stools	2	7
Vomiting or nausea	less than 1	3
Rectal incontinence	less than 1	3
Obstructive (early symptoms)	less than 1	2

longest. The results in our series cannot be correlated too closely with the pathological grouping because these cases were so advanced when first seen here that no therapy was of much avail.

It is most encouraging to note that 57 per cent of the tumors fall into the class of malignant adenomata, the least malignant of all the grades. Twenty per cent are Grade I adenocarcinomata, totaling 77 per cent of the entire number which can be placed in the two lowest grades of malignancy. This bears out and explains to a considerable extent the fact that cancers of the rectum are relatively slow growing and tend to remain localized in the bowel for a considerable time before they break through the fascia propria and invade the adjacent and more distant areas of metastasis. With this knowledge we are encouraged to attempt radical operation as often as there seems any likelihood of success and also in some instances where rectal examination is not too favorable. Although we have available for grouping pathological slides in only a third of the total cases, nevertheless it is reasonable to expect that the percentages here recorded represent a fair cross section of this series and of cancers of the rectum at large.

Knowledge that the malignancy is low in a certain case may well encourage the surgeon to operate even when the growth seems large and somewhat fixed. Fixation may be inflammatory and a cure is entirely possible. Conversely, when the malignancy is high and the patient perhaps a questionable operative risk, the grading may be the factor which decides the surgeon against operating.

The epidermoid carcinoma originates at, or close by, the mucocutaneous junction and spreads both upward into the lower rectum and outward on to the buttocks. There is a rich, subcutaneous lymphatic network around the anal opening which communicates freely with the lymphatics in the muscular coat of the lower rectum, by way of channels in the columns of Morgagni, while communication with the anorectal nodes is also quite free. Thus is explained the ease with which a

TABLE VII.—LOWER LIMIT OF GROWTH ON ADMISSION TO HOSPITAL

	Per cent	Cases
At anus and just above anus	18	56
1 to 4 centimeters	18	55
5 to 7 centimeters	20	61
8 to 10 centimeters	37	111
11 to 16 centimeters	5	16
Known data		299
No mention		4
Total		303

TABLE VIII.—CIRCUMFERENTIAL INVOLVEMENT ON ADMISSION TO HOSPITAL

	Per cent	Cases
Annular	41	117
Three-fourths of circumference	34	95
Anterior alone	15	43
Posterior alone	8	22
Right lateral alone	1	3
Left lateral alone	1	3
Known data		283
No mention		20
Total		303

growth at the mucocutaneous junction extends upward into the rectum. Likewise there is free communication subcutaneously from the adjoining skin outward in the furrow between thigh and abdomen to the inguinal nodes, and metastases here occur relatively early. It will be clearly seen that a wide local excision, if done at all, must be done very early if it is to be successful. To decide whether a wide local excision of an easily accessible early growth at the anal margin is a safe gamble is a very difficult matter. The alternative is, of course, colostomy and posterior excision of rectum, together with bilateral groin dissection.

Glandular carcinoma, developing as it does from the mucous membrane within the rectum, pursues a different course both as to direct spread and as to metastasis. It starts as a small circumscribed nodule or ulcer and spreads more rapidly around the gut than it does longitudinally, becoming annular in about a year's time. It metastasizes in three zones—upward, laterally, and downward. The growth may invade all of these zones, but if situated low in the rectum it will invade the ischiorectal fat and levators earlier than if situated high. In the same way, a high growth will metastasize upward to the iliac glands

TABLE IX.—FIXATION OF GROWTH ON ADMISSION TO HOSPITAL

		Per cent	Cases
Fixed in some degree—		86	135
Fixed in more than one quadrant		33	52
Posteriorly alone		17	27
Anteriorly alone			
To vaginal septum	25		
To prostate	12		
"Anteriorly"	15		
To bladder	4		
Total anterior		36	56
Not fixed		14	22
Total known data			157
No mention			140
Total			303

earlier than will a low growth. Liver invasion is presumably blood-borne and may be expected sooner or later from any rectal growth.

SYMPTOMS AND DIAGNOSIS

An understanding of the pathology and mode of spread of the disease makes clear the symptomatology. Ulceration comes early; therefore bleeding and the discharge of pus and mucus are early symptoms. As the growth progresses and secondary inflammation becomes more pronounced, pain may appear and the frequency of rectal discharge is increased. This results in irritation of the region of the sphincter and the tenesmus which often occurs. Obstructive symptoms are infrequent and are always late symptoms, though occasionally earlier warnings are ignored and the patient consults a doctor only with the onset of obstruction. In our series, there were only two cases in which there would seem to have been definite partial obstruction when they first came to the hospital. It occurs usually in tumors at the rectosigmoid junction because this is the narrowest part of the rectum. *Constipation* was a primary symptom in 17 per cent of the series, but we do not classify these cases as "obstructed" since they did not have colic-like pain or distention. A variety of other first symptoms, occurring in a few cases, was met with in going over the records. A classification of primary symptoms in our series is given in Table V.

Many more early diagnoses would be made if doctors more generally could be brought to appreciate the possible and, indeed, the probable significance in a particular individual of a

TABLE X.—ADMISSION EXAMINATION—SIZE OF LUMEN ON ADMISSION TO HOSPITAL

	Per cent	Cases
Nearly normal	19	27
Admits index finger	50	71
Very small	30	42
Known data		140
No mention		163
Total		303

TABLE XI.—ENTRANCE EXAMINATION—INGUINAL NODES

	Per cent	Cases
Not abnormal	91	146
"Hard"	7	12
"Enlarged"	2	3
Known data		161
No mention		142
Total		303

It will be noted in this table that in only 9 per cent of the cases were the inguinal nodes in any way suspicious. We have had in our series only one biopsy of inguinal glands with a pathological diagnosis of cancer.

change in his or her normal bowel function when that change has persisted more than a week or two. Because bleeding is so common a symptom of internal piles, doctors too often make a snap diagnosis along these lines. Thus, in our series, upon admission to the hospital, 34 patients said they had bleeding piles, 24 others had been receiving medical treatment on that assumption, and 20 others had been operated on for hæmorrhoids comparatively recently. A goodly number of these probably did have hæmorrhoids, but they had cancer also. A visiting doctor recently remarked, when someone emphasized rectal bleeding as a symptom of cancer, "Down our way we look for horses, not for unicorns." True enough, but one ought to be able to recognize a unicorn when it appears.

With early cancer of the rectum, the general practitioner usually sees a healthy appearing individual who comes in because he has seen a little blood in his movements or he has had a little rectal discomfort, or some increase in constipation or a tendency to move his bowels a little more often than usual. As a rule he has one or two formed movements a day and perhaps several additional stools of only pus, blood, and mucus. A diagnosis correctly made early gives the opportunity for radical operation and cure. Steps in diagnosis should include, in the order named:

TABLE XII.—METASTASES TO LIVER

	Per cent	Cases
Liver not palpable	87	130
Nodule palpable	5	7
Enlarged abnormally	8	12
Known data		149
No mention		154
Total		303

Metastases in the liver are not commonly detected on physical examination as can be seen in this table. In only 13 per cent was the liver thought to be abnormal. In some cases the "abnormal enlargement" may have been simply ptosis.

TABLE XIII.—GENERAL APPEARANCE ON ADMISSION TO HOSPITAL

	Per cent	Cases
Well nourished	69	122
Poorly nourished	26	46
Obese	5	8
Known data		176
No mention		127
Total		303

Pallor was noticed in 22 cases of only 68 in which any mention was made of patients' color.

Loss of weight was apparent in 27 cases of the 90 in which any mention was made of weight.

Distention was present in 34 cases of only 64 in which any mention was made. In looking over these records there was nothing else to indicate that intestinal obstruction was present, and we are inclined to believe, therefore, that they were not really obstructed.

1. Careful history (see American College of Surgeons' card);
2. Digital rectal examination as high as possible;
3. Speculum examination of anal canal;
4. Proctoscopy 2 to 3 hours after cleansing enema;
5. Barium enema only if proctoscopy is negative.

The firm induration of carcinoma, so unlike the normal elasticity of the rectal wall, is so characteristic that it is hard to understand the failure of some doctors to recognize it. Finger examination is the most important single factor in diagnosis. It is very essential to sweep the finger over every square inch of the ampulla of the rectum and to insinuate the finger past the valves to as high a point as possible. The proctoscope permits observation beyond the tip of the finger and the barium enema is of use beyond the tip of the long sigmoidoscope. The barium enema is very unreliable in the diagnosis of growths in the rectum and lower sigmoid. We wish to emphasize that in this series 95 per cent of the

TABLE XIV.—DURATION OF SYMPTOMS BEFORE ADMISSION

	Per cent	Cases
Less than 1 month	3	8
1 to 2 months	12	34
3 to 4 months	11	32
5 to 6 months	14	40
7 to 12 months	30	83
Over 12 months	30	81
Known data		278
No mention		25
Total		303
Within 4 months	27	74
Within 6 months	41	114
6 to 12 months	30	83
Over 12 months	29	81

TABLE XV.—DELAY BETWEEN ONSET OF SYMPTOMS AND CONSULTATION WITH DOCTOR

	Per cent	Cases
Less than 1 month	32	43
1 to 2 months	13	18
3 to 4 months	17	22
5 to 6 months	7	9
7 to 12 months	28	37
Slight delay	3	4
Known data		133
No mention		170
Total		303

tumors were not over 10 centimeters from the anus, or *within reach of the finger*. (See Table VII.)

THE FACTOR OF DELAY

Seventy-seven per cent (or over three-quarters) of the cases entering the hospital were considered inoperable, usually because the growth was too far advanced for removal or because the patient seemed a poor risk for radical operation. It is of interest to compare this figure with the estimate of Lockhart-Mummery that "83 per cent of the cases presenting themselves for admission to St. Mark's Hospital in London are suffering from growths in the bowel which have already reached too advanced a stage for removal to be possible." Harrison Cripps and Hartmann give an *inoperability figure* of 75 per cent for their cases, Gabriel 56 per cent, and Jones 35 per cent. It can thus be readily seen that the cases with which we deal have, for the most part, a rather hopeless prognosis with any form of therapy. This must be kept in mind when reviewing our end-results. The outcome of these inoperable cases should also be compared with that of the 23 per cent remaining who were considered operable and who were advised to submit to the complete operation.

TABLE XVI.—DELAY BETWEEN CONSULTATION WITH DOCTOR AND ENTRANCE TO HUNTINGTON MEMORIAL HOSPITAL

	Per cent	Cases
Less than 1 month	19	25
1 to 2 months	27	35
3 to 4 months	15	20
5 to 6 months	13	17
7 to 12 months	15	20
12 months	11	14
3 or more months	54	71
6 or more months	26	34
Known data		131
No mention		172
Total		303

As with cancer in other parts of the body, delay in seeking adequate treatment is responsible for the low operability and high mortality figure in the series as a whole. It is comforting, perhaps, to note in Table XV that about one-third of the patients sought their doctor within a month of the onset of their symptoms, but it is rather disquieting to observe in Table XVI that in over one-half of the cases there was a delay of 3 or more months before the patient was sent by his doctor for radium or operation and that 25 per cent of the cases were held up for a period of 6 or more months.

We would agree with Pennington that the only way we are going to get a large number of operable cancers of the rectum is by periodic health examination which should always include a rectal examination. A growth can exist for some time before it makes its presence known to the patient.

An examination of Table XVII will show some of the reasons for the delay. It will, for instance, be noted that operation was advised by the doctor in 21 per cent of the cases. Undoubtedly this advice was received with disfavor by many of the patients. The thought of an operation brings to their minds a picture of social ostracism as a result of the colostomy. It is a common experience in many clinics to have the patient state that the family doctor or friends have told him to accept no treatment that involves a colostomy.

TABLE XVII.—ADVICE AND TREATMENT RECEIVED ELSEWHERE

	Per cent	Cases
1. Referred to Huntington Memorial Hospital without advice	19	45
2. Colostomy or radical excision with or without radium	21	59
3. Operation or treatment for hæmorrhoids	16	38
4. Radium or X-ray advised	10	25
5. Medicines prescribed for intestinal troubles	10	25
6. Suppositories and ointments advised	8	19
7. Local operation advised	4	9
8. Serum, electrical and osteopathic treatments, etc. advised	4	9
9. Operation for fistula advised	1	3
10. Expectant treatment advised	less than 1	2
11. X-ray examination advised	less than 1	1
12. Treatment for rectal ulcer advised	less than 1	1
Known data		236
No mention		67
Total		303

TABLE XVIII.—OUTLINE OF TREATMENT GIVEN AT HUNTINGTON MEMORIAL HOSPITAL

	Per cent	Cases
Radiation		
Radium alone	25	76
Radium and colostomy	15	46
Radium and X-ray	3	9
Radium, X-ray, and colostomy	2	7
X-ray alone	less than 1	2
Total radiation	46	140
Radical operations		
Radical operation only	17	50
Radical operation and radium	4	13
Total radical operations	21	63
Colostomy alone	4	14
Exploratory laparotomy	1	3
No treatment advised	14	42
Treatment advised and refused—		
Radical operation	1	4
Radium alone	2	5
X-ray alone	1	2
Colostomy alone	1	3
Radium and colostomy	less than 1	1
Insufficient data	9	26
Total cases		303

This idea must be dissipated if we are going to treat patients operatively early enough to get a cure. The patient must be advised that he or she can live comfortably, both physically and socially, with a colostomy, and that only by attacking the growth vigorously and excising widely can we hope for a cure.

It is rather interesting to note that only 19 per cent of the cases in which we have data (236) arrived without having been subjected to some form of incomplete therapy or given advice along other lines (Table XVII, item 1). To be sure there were another 21 per cent who had been urged to submit to operation, but in many of these it was colostomy only that had been advised.

One explanation as to why inadequate therapy is employed is that the doctor has not, in many instances, made the diagnosis. Often he has made an incomplete rectal examination, or, in many instances, none at all. This is illustrated by the fact that 16 per cent of our cases were treated for hæmorrhoids alone (Table XVII, item 3), without the doctor suspecting that only a short distance above the hæmorrhoids lurked a neoplasm.

We have stated above, and again state here, that, as yet, radium does *not* give the patient the best chance of cure. It is a common experience to have a patient say, "My doctor told me that we would try radium for a while, and if that did not work we would then talk operation." Twenty-five patients were so advised before they came to the Huntington Hospital.

Suppositories and ointments were prescribed in 8 per cent of our cases—probably on the supposition that hæmorrhoids or fissure were being dealt with. Perhaps these lesions were actually present, but with *carcinoma coexistent*.

If operation is advised it should be nothing short of a complete one, which means almost without exception that a colostomy will have to be included. We are glad to note, therefore, that in only 4 per cent of the cases did the doctor, knowing it was cancer, advise a local excision.

Item 8 in Table XVII can be dismissed without much comment, as the readers of this article undoubtedly will agree that with our present knowledge of cancer, to advocate such inadequate therapy of cancer of the rectum is certainly in the realm of quackery. It is not that the treatment *per se* is harmful—it usually is not—but that precious days and weeks are wasted while the growth advances unchecked.

TABLE XIX.—NOW LIVING WITHOUT SYMPTOMS—RADICAL OPERATIONS

Time since operation in years	Our classification	Pathological report	Type of operation
11½	1C	Adenocarcinoma, grade 2	Abdominoperineal, 2 stage.
10	1A	Malignant adenoma	Abdominoperineal, 2 stage.
9	3B	Malignant adenoma	Colostomy and posterior excision.
8	1A	Adenocarcinoma, grade 2	Abdominoperineal, 2 stage.
7	1C	Malignant adenoma	Abdominoperineal, 1 stage.
7	2D	Epidermoid carcinoma, grade 2	Colostomy and posterior excision.
7	1C	Adenocarcinoma, grade 2	Abdominoperineal, 1 stage.
6	1A	Epidermoid carcinoma	Colostomy and posterior excision, bilateral groin dissection.
6	1A	None	Perineal resection alone (?).
5	1A	Adenocarcinoma	Abdominoperineal, 2 stage.
5	1B	Adenocarcinoma	Colostomy and posterior excision.
5	1A	Adenocarcinoma, grade 3	Colostomy and posterior excision.
5	1C	Adenocarcinoma, grade 2	Abdominoperineal, 1 stage.
5	1C	Malignant adenoma, tuberculosis adjacent nodes	Abdominoperineal.
3	1C	Malignant adenoma	Abdominoperineal, 2 stage.
3	1A	Malignant adenoma	Abdominoperineal, 2 stage.
2	1A	Adenocarcinoma, grade 2	Abdominoperineal, 2 stage.
2	1A	Adenocarcinoma, grade 2	Abdominoperineal, 2 stage.
2	1B	Epidermoid carcinoma, grade 3	Colostomy and posterior excision.
2	1A	Malignant adenoma	Not known.
2	1B	Malignant adenoma	Abdominoperineal, 2 stage.

In 3 cases operation for fistula was advised. An ordinary anal fistula may exist with a cancer and with neither related to the other. Likewise, a carcinomatous fistula may develop secondary to a growth low in the rectum.

In 2 cases the doctor advised "expectant treatment," though what benefit was expected to issue from this is hard to understand.

One case was advised to have an X-ray examination. We assume this was a barium enema. We have indicated already that X-ray with cancer of the rectum below 15 to 20 centimeters from the anus is notoriously uncertain. The diagnosis of cancer of the rectum may be made with the finger in 95 per cent of the cases.

One case had a rectal ulcer which was treated locally. Any ulcer persisting over 2 weeks must be looked upon with suspicion. Biopsy can be done at any time with safety.

DETERMINATION OF TYPE OF TREATMENT

Radical operation. Cancer of the rectum, though insidious in its onset, has the redeeming feature of remaining localized to the bowel for a considerable period. Just how long this is, one cannot say with any certainty, but probably in some cases even as long as a year. Furthermore, as has been pointed out previously, about 77 per cent of these tumors are of the two lowest grades of malignancy. Therefore, if we can get the patient early, and if he will consent to have an adequate operation performed, his chances of a permanent cure are very good. In this series, unfortunately, only 69 cases were considered as at all favorable for operation, and 63 of these submitted to a complete operation. Of this number many were borderline cases as to operability. Had they been seen 6 to 12 months earlier the outcome might have been different. These cases were operated upon by various surgeons, a few by ourselves and the majority by Dr. D. F. Jones.

What, then, constitutes a proper operative procedure? The result to be achieved is constant, the technical procedure varies somewhat with the location of the growth. Removal of the entire rectum with the growth and a margin of several inches of normal bowel above must be accomplished. The specimen should include, intact, the following structures; the anus and a wide ellipse of skin around it, a wide removal of ischiorectal fat, the entire levatores, all retrorectal tissue including mesosigmoid up to the point of branching of the left colic artery from the inferior mesenteric. The dissection should go laterally to the ureters, and should be limited anteriorly only by bladder and prostate or vagina, and posteriorly by the sacrum. Colostomy is always necessary. The combined abdominoperineal operation, either in one or two stages, as described by Miles, Jones, Coffey, Rankin, and others, is the ideal procedure. Mummery uses simple colostomy and a wide, high posterior excision more generally than would seem wise, but this is an

excellent operation for low growths and early ones. The operation of Hartmann is very useful for a high growth, the dissection being carried abdominally below the tumor, and resection done here, inverting the rectal stump to be later excised. The surgeon must have at his command four or five procedures, each suited to a certain situation, but all of a magnitude which accomplishes wide removal of growth and gland bearing areas. These operations have all been clearly written up, and it is superfluous to describe them again in this paper.

Cases now living after radical operation. Of the 63 cases in this series who had radical operations performed, 21 are now, December, 1929, living after varying periods of time (Table XIX). Although a pathological report is lacking in 1 of this group, the descriptions of the growth and opinions expressed lead us to think that it was undoubtedly cancer. In the 3 epidermoid carcinomata it will be noted that colostomy and posterior excision were performed. This, of course, is a logical procedure because there is not a great chance of the higher iliac nodes being involved. In one of these cases bilateral groin dissection made the chance of cure greater, and it should be carried out in all epidermoid cases. The abdominoperineal operation was done in 13 cases, colostomy and posterior excision in 6. The latter were all low growths with one exception. In 2 cases the exact type of operation could not be ascertained. Our classification shows 10 1A, 3 1B, and 6 1C cases. In other words, 14 of the 22 were considered to have movable growths and to be good prospects for radical removal, and the results have justified the procedure. It is of interest that the 6 1C cases are also cures, suggesting that their fixation was probably inflammatory rather than due to extension of growth. Of the two remaining cases, one is a 9 year cure with colostomy and posterior excision after a hæmorrhoid operation from which a pathological report of adenocarcinoma resulted. The last case was an epidermoid carcinoma, and the patient was operated upon previously with a diagnosis of hæmorrhoid. He is now a 7 year cure following colostomy and posterior excision.

TABLE XX.—RADIATION THERAPY

	Per cent	Cases
1. Radium alone	55	76
2. Radium and colostomy	33	46
3. Radium and X-ray	6	9
4. Radium and X-ray and colostomy	5	7
5. X-ray alone	1	2
Total		140

Cases now dead after radical operation. Of the 63 cases operated upon radically, 41 are dead. Three of these were operative fatalities and a fourth died one month later. (This does not represent a true operative mortality as some of these cases came to us after operation elsewhere.) Most of the others died with recurrent malignant disease, we know, and the remainder in all probability did. This group, exclusive of the operative fatalities, survived an average of 2 years and 4 months after operation. One case survived 7 years and died of recurrence. He had an abdominoperineal operation following a previous incomplete operation. The pathological report was malignant adenoma, and he was treated with radium also. Three cases lived 5 years or slightly over. All died with carcinoma present. One case, a *colloid* carcinoma surviving operation only 6 months, showed on postmortem examination metastases in the heart, lungs, gall bladder, adrenals, intestine, and stomach. The liver was not mentioned. Of the types of operation which were performed, 15 were colostomies with posterior excision, there were 22 abdomino-perineal operations, there was one Harrison-Cripps operation, and 3 were uncertain.

Radium and X-ray treatment. Of the 76 cases treated by radium alone (Table XVIII) there were 29 (38 per cent) grouped clinically as 1A—that is, they had had no previous treatment and it was felt that the prognosis for cure would be good if the radical operation were done. They received radium either because they refused, or their general condition precluded, operation. The growths in these cases were not fixed to the surrounding tissue and there was no palpable evidence of metastases. Of the 29, 24 are dead of cancer. They survived an average of approximately 20 months from the time of entrance—the longest duration being 3 years and 10 months

and the shortest 1 month. We have recently (December, 1929) reviewed the 5 cases living in January, 1928, and also checked over the pathological specimens. One case is well 4 years after she entered the hospital but our present pathologist, Dr. Shields Warren, feels that the original report of malignant adenoma was an error and that the growth should have been called a benign adenoma. A second died 2 years and 5 months after entrance with no clinical evidence of cancer. The pathologist states that the growth was borderline between polyp and malignant adenoma. The 3 others cannot be classed as cures as we have no pathological reports. One is living 6 years after entrance. The original growth was described as papillary, about 2.5 centimeters in diameter and about 7 centimeters from the anus. A second case had a growth 3.5 centimeters in diameter, an indurated, firmly fixed ulcer 8 centimeters from the anus. This patient is living 7 years after entrance. A third, Dr. D. F. Jones believed to be cancer and was located about 8 to 10 centimeters from the anus. She is living 10 years after entrance.

In the earlier cases treatment consisted of surface application. Later glass "seeds" were used, but for the past 3 years we have been employing only metal "seeds," the screening in these being 0.3 millimeters of gold. Through a trocar we embed them in the growth. We have been using the gold seeds too short a time to warrant a statement as to results, but we are encouraged to persist in their use by the fact that the patients have much less local reaction and can thus be treated with much heavier dosage. The results of the treatment with gold seeds and with diathermy we hope to report in a later paper.

In the 1B group, that is, those in which the growth had penetrated the bowel wall but had as yet not invaded the perirectal tissue, there were 21 cases, 27 per cent of all those treated with radium. The average time these patients survived was 11 months from the time of entrance, the longest duration being 2 years and 8 months, and the shortest, 1 month. None of them is now alive.

As we have stated elsewhere in this paper, 77 per cent of the tumors were of a low degree of malignancy (i.e., malignant adenomata or adenocarcinomata, grade 1).

It is agreed that the lower the degree of malignancy the less radiosensitive is the tumor. Therefore it is not surprising that these carcinomata of the rectum have responded only feebly to the doses that we have been able to give.

Carter Braine, of Guys Hospital, London, states that "intracavitary application has failed deplorably except in conjunction with other methods." We would agree with this heartily.

Pennington describes the experiences of a few of the clinics which are using radium on a relatively large scale in treating cancer of the rectum. Lecéne had but mediocre results. Kuettner saw remarkable benefits in some instances, others were unchanged, some improved for a time only, and still others seemed to be made worse. Quick treated 160 cases with radium. A large number were benefited from 1 to 3 years. The oldest ones were of 4 years' standing. The number of cures is not stated.

The remainder of the group treated by radium were those obviously too far advanced to treat other than palliatively. There were 26 such cases and if we add the 39 advanced cases, handled with radium plus a colostomy, and the ones which had radium and X-ray, we have a total of 83 (61 per cent of all those treated with radium). It is this group that constitutes a real problem for the man employing radiotherapy. Many were benefited symptomatically by a reduction in the size of the tumor; for with the removal of part of the sloughing mass, there is a consequent reduction in the area of secondary infection and rectal tenesmus is often thus brought to a minimum.

It is probable, however, that surgical diathermy will supplant to a great extent radium used as a palliative measure. We have employed it in a few instances and think it has definite possibilities.

There is one very obvious disadvantage in attempting to treat an annular tumor from below, namely that if the lumen of the growth is small, only its lower border can be attacked. The growth can occasionally be attacked from

above by passing a small proctoscope down through a colostomy and embedding seeds through a trocar. There are two definite objections to this technique. The first is that usually only the upper border can thus be approached and the second is that there is a certain amount of danger in exerting leverage on the gut with the instrument.

Interstitial needling as performed by Neumann and Coryn of the Radium Institute of Brussels and described by Ogilvie seems to be a fairly effective technique. They report 4 3-year cures out of 9 cases which we would probably class as 1A. They also had 4 3-year cures out of 28 inoperable (1C) cases. These combined give a 3-year cure figure of 20 per cent. No pathological reports are mentioned. Their original paper appeared in the European journal *Cancer*, published in Brussels in 1927 and is not available to us.

Neumann and Coryn make an incision around the anus and free the rectum from its attachments so that radium can be inserted into the growth externally and also into any perirectal infiltration of the neoplasm. Lockhart-Mummery uses a similar technique. He implants perirectally ten or twelve needles, each containing about 10 milligrams of radium bromide and leaves them in place for 24 to 36 hours. A colostomy is often included in the treatment.

Lockhart-Mummery feels that the technique of Neumann and Coryn has considerable merit. He adds that radium should *always* be inserted from the outside of the rectum. Gordon-Watson has been able to employ as much as 53.5 milligrams at one dose with this method, employing a maximum of 9,840 millicurie hours. We have had no experience with this method as yet. Sampson-Handley and others feel that there is reason to hope that ultimately operative procedures on carcinoma of the rectum will be abolished by improvements in radium treatment.

This method of radiation has definite possibilities. It seems radical compared to our present technique, but there is no reason why it could not be carried out. A patient who could not stand a colostomy and posterior resection might well be able to stand a colostomy under local anæsthesia and then a freeing of the rectum under sacral anæsthesia so as to get at the growth without attempting a resection.

Binkley, of the General Memorial Hospital, New York, uses a radium pack employing two portals of entrance and giving about 10,000 millicurie hours at 10 centimeters distance, or he employs a cycle of high voltage X-ray treatment. He also uses gold seeds with 0.3 millimeter screening, giving from 10 to 65 millicuries (1300 to 8500 millicurie hours) at a dose. He plants the seeds via the rectal canal, the perineum, or posterior vaginal wall.

Binkley's figures are very encouraging. He reports 19 patients treated before 1925 alive for periods varying from 2½ to 7 years. In a verbal communication he states that most of these cases had pathological reports and that several are alive now. He further reports 100 cases treated between the years 1925 and 1927. Eighteen are free from disease. Many of these, he says, had pathological reports. If these are all cancer and if they live over 5 years without disease, he will have almost 20 per cent cures, which tallies well with the figures of Neumann and Coryn.

It is possible that in the future we may be able to render operable a seemingly hopeless case by the combined use of diathermy and radium used interstitially. Surgery with cancer of the rectum has very nearly reached its therapeutic limit but radium treatment of this disease is as yet very young. If a case is operable locally but the patient's general condition precludes a radical operation, an attempt can thus still be made at cure. We must bear in mind, however, that unless radium be given in adequate single dosage (i.e., 7,000 to 10,000 millicurie hours) it will not, save in rare instances, cure cancer of the rectum. Neumann and Coryn's technique should be carefully considered as their figures give more hope than any data heretofore published. We feel, however, that until their method has been carefully checked and its worth proved, radical operation is the method of choice as offering the patient the best chance of cure.

X-ray treatment. We are *at present* giving our patients the following X-ray treatment

TABLE XXI.—AVERAGE LENGTH OF LIFE WITH DIFFERENT TYPES OF TREATMENT

Treatment	Cases	After onset of symptoms*	After entrance to Huntington Hospital*
1. No treatment	42	24	12
2. Colostomy alone	14	28	12
3. Radium alone	76	22	13
4. Colostomy and radium	46	32	17

—1100 R units—170 K.V.—½ mm. copper filter. Field 20 x 20 cm.

We feel that the former X-ray technique, in which only 120 kilovolts were used, is useless. We have not yet accumulated sufficient data regarding the present method to venture an opinion on it.

We do not advise pre-operative treatment with radium for two reasons; first, because it delays adequate operative therapy and delay, of course, is never advisable in the presence of a neoplasm; and second, because such treatment makes the operation technically more difficult. Both of us have operated by the abdominoperineal route on patients so treated pre-operatively. In each instance the area of radiation was solidly fixed to the surrounding tissues, thus making it almost impossible to get a line of cleavage.

We are not impressed with the benefits to be gained by employing a colostomy before radiation as a routine measure. Each case must be considered as an individual problem. In some instances the secondary inflammatory reaction around the growth does subside after the fæcal stream has been diverted, but in others there is no such change and the patient may be made even worse symptomatically. It is possible, however, that as we develop a more radical technique of radiation, colostomy will again have to be frequently employed.

It can be seen in Table XVIII that radium and X-ray have not materially improved the patient's prognosis and that those receiving no treatment at all seemed to do as well if not better than those who have had X-ray or radium or both. In our series, 42 cases received no treatment. The duration of life, from onset of symptoms, averaged 23.5 months. In this connection, the natural duration of cancer is of interest. Lazarus-Barlow, of the Middlesex Hospital, studied 345 instances of untreated cancer of the rectum. He found that the average length of life with males was 20.4 months. With females the average was 25.9 months.

Wyard, in England, studied 450 cases. The average length of life was 29 months. Many of his and of Lazarus-Barlow's patients had colostomies, but their experience with regard to colostomy coincides with ours, namely, that it alone does not prolong life sufficiently to warrant its routine use (Table XXI).

Colostomy as an adjunct to radiation apparently adds 4 months to the life of the average patient, but this is not always an unmixed blessing as many times the patient has thus not only the discomfort of a rectal growth but also the annoyance of caring for a colostomy.

Howard Kelly reports his experience with radium in the treatment of 133 cases. Seven of these, he says, lived over 3 years. One lived over 5 years. Twenty-seven per cent were not benefited at all.

*Expressed in months.

SUMMARY AND CONCLUSIONS

1. This series embraces 303 cases clinically diagnosed cancer, between 1912 and 1928.

2. Adenomatous polyps constitute the most dangerous precancerous lesion.

3. The fifth decade of life shows greatest incidence of cases.

4. Family history of cancer is obtained in only 7 per cent of the cases.

5. Malignant adenoma and adenocarcinoma grade 1, the two lowest grades of malignancy, form 77 per cent of the 101 cases available for grading.

6. Biopsy for diagnosis, prior to instituting therapy, is always advisable and never harmful.

7. Change in bowel habits, bleeding, and rectal pain should always suggest the possibility of cancer even though hæmorrhoids also are visible.

8. Digital rectal examination is sufficient to make a diagnosis in 95 per cent of cases.

9. Every cancer of the rectum is operable if discovered early enough, and the period during which it remains operable is longer than in most other cancers.

10. Obstruction necessitating emergency colostomy is rare in rectal cancer.

11. Colostomy, as an adjunct to radical operation, is always necessary.

12. In the entire series only 21 cases who had positive pathological reports of cancer, are alive without symptoms, and *all* have had complete operations.

13. A radical resection, by one of several methods, and including colostomy, offers the patient his best and, we believe, practically his only chance of cure.

14. Radical operation definitely prolonged the life of the 42 who subsequently died of recurrence.

15. Radium and X-ray, as at present used, must be considered purely as palliative agents in the treatment of cancer of the rectum.

16. Our patients receiving no treatment lived about the same length of time, on the average, as did those radiated as described. Changes in technique of application may, in the future, improve this situation.

17. Surgical diathermy is of use in reducing the bulk of an inoperable growth.

We wish to express our thanks to Dr. Shields Warren, Dr. Lawrence Sophian, and Dr. William H. Lewis, to whom we are greatly indebted for their painstaking work in the pathological grading of the material from our cases.

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RESPIRATORY COMPLICATIONS AND THE SURGICAL PATIENT[1]

HAROLD L. FOSS, M.D., F.A.C.S., and JOHN H. KUPP, M.D., Danville, Pennsylvania

THIS paper is based on a study of the complications developed by the patients on a general surgical service for the 3 year period ending December 31, 1929. There were 3,433 operations in the series. From time to time the results of studies of similar groups have been reported, and with each succeeding study the incidence of complications has increased while the mortality has correspondingly decreased, a fact noted in the papers of many authors but, probably, instead of indicating an actual increase, rather suggesting an increasingly more careful analysis of postoperative complications.

In 1898, Schultze reported from Whipple's study an incidence of 0.38 per cent of postoperative pneumonias. In 1913–1914 (Whipple, 27, 28) the incidence was 2.2 per cent, while in 1915–1916 it was 2.6 per cent. Cutler and Hunt (3, 4) reported 1.86 per cent (1916), 3.52 per cent in 1920, and 3.92 per cent in 1922 for all pulmonary complications and, with the increase in morbidity, a corresponding decrease in mortality.

The earlier papers dealt with broncho and lobar pneumonia only, but as time passed, the group enlarged to include other intrathoracic lesions especially infarction and massive collapse which have come, in late years, to be better understood. In Table I is shown the incidence of pulmonary complications recently reported from several well known clinics. In the chronological arrangement, taken from Cutler and Hunt, the increasing morbidity with the concomitant decrease in mortality is well illustrated. Our own figures, as well as those of Decker, Ravdin and Kern, disagree somewhat with these. The trend of opinion favors the embolic origin of pulmonary complications, and the hypothesis that the aspiration of foreign and infected material is the chief cause of postoperative pneumonia is giving away largely to the former theory. Among those advocating the embolic theory may be mentioned Cutler and Hunt, Schlueter and Weidlein, and Fetterolf and Fox, while those favoring the aspiration theory include Hoelscher, Ochsner and Nesbit, Lemon, Smith, Moore, Crowe and Scarff, Allen, Myerson, and Iglauer. Undoubtedly, as has been repeatedly proved by animal experimentation (Lee, 12), aspiration of septic material may result in pneumonia and massive collapse, yet there is increasing evidence pointing to the frequency of postoperative embolism as the one condition preceding many cases of postoperative pulmonary disease.

The patients admitted to our service are less prone to respiratory conditions than patients seen in the larger cities. Most of them are sturdy farmers and railroad or mill workers who live relatively healthy lives. The conditions for which operations are performed compare with those in most general hospitals (Table II). In the 3 year period there were 3,433 operations performed on the general surgical service (that of H. L. F.).

Sixty patients (1.7 per cent) of this series developed pulmonary complications and of these 25 (0.72 per cent) died. Of every 58

[1] From The Surgical Service, Geisinger Memorial Hospital.

TABLE I.—PULMONARY COMPLICATIONS

Clinic	Author and year	No. of operations	Pulmonary morbidity		Pulmonary mortality		Mortality per cent of morbidity
			No.	Per cent	No.	Per cent	
Montreal General Hospital	Armstrong, 1906	2,500	55	2.2	32	1.28	58.1
Von Eiselsberg, Vienna	Ranzi, 1909	6,871	263	3.8			
Combined Statistics	von Lichtenberg, 1908	23,673	440	1.9			
Mayo Clinic	Beckman, 1910	3,657	41	1.12	9	.24	21.0
Mayo Clinic	Beckman, 1912	5,835	92	1.57	6	.10	6.5
Mayo Clinic	Beckman, 1913	6,825	87	1.27			
Mass. General Hospital	Cutler and Morton, 1917	3,490	65	1.86	33	.94	50.7
Combined Statistics	McKesson, 1918	39,438		3.03		1.06	
Peter Bent Brigham Hospital	Cutler and Hunt, 1920	1,562	55	3.52	11	.7	20.0
Pittsburgh	Decker, 1921	5,976	69	1.2	29	.5	42.0
Peter Bent Brigham Hospital	Cutler and Hunt, 1921	1,604	63	3.92	5	.31	7.93
Philadelphia	Ravdin and Kern, 1922–1925	5,966	69	1.15	28	.47	40.6
Geisinger Memorial Hospital	Foss and Kupp, 1926–1929	3,433	60	1.70	25	.72	41.7

operations a pulmonary complication developed, and of every 137 operations, 0.72 per cent, the patient died as the result of the complication. The lesions studied have been classified as follows: lobar pneumonia, bronchopneumonia, bronchitis, embolism, infarction, massive collapse, and lung abscess. Following Cutler and Hunt, we list under *infarctions* those lesions often referred to as "postoperative pleurisy" and characterized by the appearance of sudden sharp pain in the chest with expectoration of mucus, occasionally blood stained, and, later, the presence of a friction rub, impaired breath sounds, impaired resonance, etc.,—the group to which Wharton and Pierson have applied the term "minor emboli." This group should be separated from the group in which massive pulmonary embolism develops and which usually terminates fatally. Although it is probable that these minor emboli are produced by the same mechanism that results in fatal pulmonary embolism, in the latter condition the obstructing mass is relatively much larger, producing complete occlusion of main pulmonary vessels. There is bound to be confusion in the differential diagnosis of these various lesions unless the chests are meticulously examined by one thoroughly versed in thoracic disease. While the exact diagnosis may be missed, the existence of some intrathoracic lesion is, however, usually recognized. Recent studies tend to prove that the term "postoperative pneumonia" is far from an accurate one and that the majority of lesions developing within the lungs following surgical procedures are not true pneumonias.

LOBAR PNEUMONIA

There were in the entire group 3 cases of frank lobar pneumonia. Two recovered and one died. All the patients were under 40

TABLE II.—OPERATIONS ON GENERAL SURGICAL SERVICE

February 1, 1926—January 31, 1929	Cases
Appendix	315
Gall bladder	259
Small bowel	17
Large bowel	27
Rectum and anus	138
Stomach and duodenum	62
Abdomen, miscellaneous	109
Tongue	2
Œsophagus	3
Herniorrhaphies	216
Breast	68
Genito-urinary	256
Gynecological	612
Thyroid	355
Skull	3
Nerves or tendons	66
Arteries and veins	15
Extremities	393
Bones	317
Drainage of abscesses	168
Glands	32
Total	3,433

years of age. There was no history or sign of previous pulmonary disease. The average day of onset was the fifth following operation.

BRONCHOPNEUMONIA

There were 16 cases of bronchopneumonia; 10 of these patients died. The ages ranged from 16 to 74 years. Ten patients were operated on for non-septic lesions and 6 for septic. Three of the patients who died were suffering from septic conditions. The anæsthetic used was ether five times, ethylene five, local infiltration one, nitrous oxide three, ether and nitrous oxide one, and local and ethylene one. On leaving the table, the condition was good in 11 cases, fair in 1, poor in 3, and very poor in 1 case. Of the 10 patients who died, 7 left the operating table in good condition. The condition of the patient on leaving the operating room is rarely an indication of the likelihood of the development of a pulmonary complication. All patients took the anæsthetic well, neither induction nor maintenance being difficult. The average duration of anæsthesia was 42 minutes. Nine of the patients had abdominal operations, 2 in the upper abdomen and the remainder in the lower abdomen and pelvis.

In 6 cases the pneumonic process was confined to both bases. The right base was involved in 6, the left in 3, and the entire left lung in 1. The average day of onset was the seventh following operation.

BRONCHITIS

There were 11 patients in this group; 2 had histories of previous chronic bronchitis. Three patients had bilateral resections of the thyroid, while the 8 remaining were operated upon for the relief of abdominal conditions. The ages ranged from 18 to 65 years. The anæsthetic was ether in 7 cases, ethylene in 2 cases, local in 1, and local and nitrous oxide in 1 case. The administration of the anæsthetic was satisfactory in all cases. On leaving the operating table, the condition of 7 patients was classed as good and of 4 as fair. The duration of the anæsthesia ranged from 20 to 90 minutes, the average being 41 minutes.

In 9 of the 11 patients the complications occurred during the first week. Four developed on the first day, three on the second day, one on the third day, one on the sixth day, one on the forty-eighth, and one on the sixty-fifth day. The duration was from 3 to 17 days, and the average duration was 9 days. The early development of this complication and the fact that it seems to be prone to follow inhalation anæsthetics, especially ether, supports the theory that, at least with postoperative bronchitis, the anæsthetic is the chief cause.

The majority of such patients recover without further complications, although a few develop lobar or bronchopneumonia.

INFARCTION

Rarely was this diagnosis primarily made, but a rereading of the histories and an analysis of the physical findings, temperature curves, etc. lead us to increase its incidence. We believe, therefore, that in the group of 60 patients suffering from postoperative pulmonary complications 15 had infarctions, although the diagnosis was not positively made at the time. In the group is placed the patient suffering from what is usually called pleurisy as well as the borderline case which cannot be placed in the lobar pneumonia, bronchopneumonia, or bronchitis group,—the patient presenting the syndrome of the condition to which Wharton and Pierson have referred as "minor emboli." Of the 15 patients 12 were operated upon for non-septic conditions, 3 for septic. The syndrome consisted of the occurrence of a sudden sharp pain in the chest preceded and followed by a rise in the temperature and respiratory rate and a marked rise in the pulse rate. There was expectoration of mucus in 8 cases; in 5 it was bloody. Examination of the chest revealed râles over small areas with small areas of slight impairment of breath sounds. It was usual to find small areas of impaired resonance. Within the first 2 days friction rubs were found in 3 of the cases. Ages ranged from 15 to 64 years. Eight of the 15 patients were more than 50 years old. Five were males and 10 females. The anæsthetic was ether eleven times, ethylene twice, local once, and ethylene and local once, the average duration being 45 minutes. All patients had laparotomies, 7 in the upper and 8 in the lower abdomen. Two patients had two attacks

and one, three. Three of the patients developed a coincidental phlebitis. The duration of symptoms averaged 4 days, and the average day of onset was the seventeenth following operation.

It is interesting to note that postoperative bronchitis developed within the first week, while in cases of infarction not until the second or even third week. It is also worth noting that only with the cases of infarction was there a coincidental phlebitis.

EMBOLISM

There were 13 patients in this group, all succumbing to the condition. The criteria required in making the diagnosis of massive acute pulmonary embolism were: sudden and severe pain in the chest associated with cough and expectoration of mucus, usually respiratory embarrassment with cyanosis, and death usually within a few minutes. All the patients in this group died within 2 hours following the onset of symptoms. Nine patients (69 per cent) were over 50 years of age. Six presented a history of chronic bronchitis preceding the operation. Eleven were definitely poor risks. The anæsthetic used was ether seven times, ethylene twice, and nitrous oxide four times. When the patients left the operating room, 6 were in good, 3 in fair, 1 in poor, and 1 in very poor condition. Four of the operations were for septic lesions and 9 for non-septic. The average duration of the anæsthesia was 43 minutes. Nine patients had abdominal incisions, 4 in the upper and 5 in the lower abdomen. One patient had a radical amputation of the breast, while with 3 the operation was performed on the extremities. In all cases the symptoms appeared suddenly and, usually, after a normal, uneventful convalescence.

Deaths occurred as follows: on the first postoperative day 1, fourth day 1, fifth day 1, sixth day 1, seventh day 2, eleventh day 4, twenty-fourth day 1, thirty-third day 1, and forty-first day 1. The average duration between the onset of symptoms and death was 57 minutes. One patient experienced on the twenty-fourth day a sudden sharp pain in the chest associated with dyspnœa and tachycardia, and from this condition he recovered only to succumb to a second attack on the forty-first day. Postmortem examinations were permitted in about one-third of these cases, in each instance a large thrombus being found in either the right or left main pulmonary artery.

MASSIVE COLLAPSE

There were two examples of this complication. With the histories again before us, we are bound to feel that where two cases were reported, several were overlooked or were incorrectly listed under pneumonia, bronchopneumonia, infarction, etc. With our far better understanding of this extraordinary condition, the surgical complication records of all hospitals are bound to show an increasing incidence. The generally accepted criteria were present in both of our cases. Respiratory movements were restricted on the affected side and the cardiac impulse displaced toward that side, the apex exhibiting a tendency to tilt upward and outward. The dome of the diaphragm was found to be abnormally high and immobile on the affected side. Both of our patients were males. One, who was 20 years of age, had a right inguinal herniorrhaphy and had suffered from chronic bronchitis for several years. The operation was performed under local anæsthesia. The day following the operation the temperature rose to 104 degrees, the pulse rate to 110, and the respiratory rate to 32. The patient developed a non-productive, irritating cough, and roentgenograms of the chest made a day later showed the characterized appearance of massive collapse. The temperature became normal after the sixth day, the patient fully recovering and being discharged on the fifteenth day.

ABSCESS

One patient developed a pulmonary abscess. The patient, 62 years of age, had received a gunshot wound resulting in a fracture of both bones of the leg. A month later an amputation had to be performed, and on the second day following the operation the patient developed bronchopneumonia which was followed later by the formation of an abscess. The patient ultimately recovered.

TABLE III.—ANÆSTHETICS AND POSTOPERATIVE MORTALITY

Anæsthetics	Number of administrations	Number of deaths	Mortality
Ether	1146	10	0.87
Ethylene	746	4	0.62
Nitrous oxide	626	6	0.95
Local	437	1	0.23
Nitrous oxide-ether	384	2	0.52
Ethylene-ether	20	1	5.0
Other combinations	56	0	0.0

COMMENT

In a series of 3,433 major surgical operations there were 60 instances of postoperative pulmonary complications. Of the 60, there were 15 cases of infarction, "minor emboli"; 3 had more than one attack; 3 had an associated phlebitis. Sixteen patients developed bronchopneumonia. Three had attacks of sudden sharp pain and evidence of infarction prior to, or during the course of, the pneumonia. Three had previous pulmonary disease. There were 3 cases of frank lobar pneumonia. There were 13 cases of pulmonary embolism, all terminating fatally. There were 11 cases of postoperative bronchitis. Eleven (18⅓ per cent) of the 60 patients had evidences of preexisting pulmonary lesions.

The fact that most of the pneumonias are bronchial rather than lobar in type would indicate that they are caused by minute emboli. We believe that infected emboli and previous pulmonary disease play a more important part in the production of these complications than does aspiration of septic substances or irritation from the anæsthetic. It is probable, however, that irritation plays a part in the acute postoperative bronchitis cases, most of which develop during the first 2 days following operation.

It is interesting to note that in the majority of cases of infarction and embolism, the onset was at a much later date than was the case with the bronchitis or pneumonia. The infarction patients recovered in about one-half the time required for those with bronchitis.

Arguments favoring the embolic origin of postoperative pulmonary lesions are; (1) late (i.e., after the sixth day) onset with sudden pain, few râles and, in a few cases, impaired breath sounds, with rapid recovery; (2) appearance of more than one attack; (3) associated occurrence of phlebitis in some cases; (4) frequent occurrence after local anæsthesia.

In Table III is shown the mortality percentages with respect to the anæsthetics used; although most of the serious cases were operated under ether.

During the 3 years in which these operations were performed, in the nose and throat department there were 1,572 operations, tonsillectomies, adenoidectomies, submucous resections, etc., all under anæsthetics, mostly ether. There were no pulmonary complications. In the 10 year period, 1919–1928, among 4,182 consecutive operations there was not a pulmonary complication in this department. Of course, since the nose and throat patient averages only 2 or 3 days in the hospital, he may develop a complication after returning home although no such cases have been reported to us. This is an interesting comparison of the incidence of pulmonary complications of general surgery with that of otolaryngology, performed in the same institution under like conditions and with same operating room attaches, nurses, and anæsthetists.

TABLE IV.—PULMONARY COMPLICATIONS FOLLOWING SPINAL ANÆSTHESIA

Operation	Age	Postoperative complications	Days after operation (Onset)	Result
Prostatectomy	58	Pleuritis	14	Recovered
Cholecystectomy	33	Collapse, right lung	21	Recovered
Colostomy	75	Infarction and bronchopneumonia	17	Recovered
Appendectomy	55	Pleuritis	23	Recovered
Cholecystectomy	51	Massive collapse	12	Recovered
Cholecystectomy	64	Hypostatic pneumonia	2	Died
Appendectomy	48	Pleuritis	14	Recovered

May, Thoburn, and Rosenberger have recently studied, radiographically, the aspiration of iodized oil into the bronchial tree of patients undergoing tonsillectomies. They conclude that some aspiration is unavoidable in all operations requiring an inhalation anæsthetic. In their series of patients they found that aspiration occurred in 48 per cent.

Similar conclusions were reached by Myerson (18) who, in a series of 200 cases, reports an aspiration percentage of 75 while the Dailys, in their series of 100 cases, report aspiration as occurring in 78 per cent. Iglauer

and his associates in 100 bronchoscopies performed after tonsillectomy report aspiration of mucus or tissue particles as occurring in 40 per cent.

These data, of course, tend to convince one that aspiration of mucus and foreign substances from the throat does not constitute the serious menace we have believed it to be, and that it is, probably, less important in the production of pulmonary complications than the deposition of emboli brought to the lungs by way of the blood stream from the operative field, especially following abdominal and other operations performed by the general surgeon. Exception might be made in the case of abscess. Cutler (5) shows in a recent survey that of 1,908 cases of lung abscess reported by various authors, 29 per cent followed general surgical operations, while 14 per cent were incident to tonsillectomy. Hedblom, in a report of 146 cases of postoperative lung abscess observed at the Mayo Clinic, found that 38 per cent followed laparotomy and 33 per cent tonsillectomy.

In November, 1928, we adopted spinal anæsthesia to the exclusion of all other forms in operations performed below the diaphragm. With the first 400 operations there was an incidence of 1.7 per cent of pulmonary complications; equal to that in our previous series of patients operated under inhalation anæsthetics (1.7 per cent).

The incidence of pulmonary complications, especially those of the pneumonic group, is greatest during the months of November, December, January, and February, the mortality being then correspondingly increased. The lobar and bronchopneumonias occurred almost invariably during these months. All but 4 of the 19 cases of bronchopneumonia and lobar pneumonia occurred between October and February.

There is a greater likelihood of pulmonary complications developing as age advances. The incidence was highest in the period from 51 to 60 years. Thirty-eight cases (61 per cent) occurred in patients over 40 years of age.

CONCLUSIONS

1. We believe that this study further strengthens the theory that embolism plays the chief part in the production of most postoperative pulmonary complications.

2. Infarctions (minor emboli) are far more common than has been generally supposed.

3. Aspiration plays but a minor rôle in the production of pulmonary complications.

4. Pulmonary complications are infinitely less common following operations on the upper respiratory tract than following operations on the abdomen and pelvis.

5. Irritation by the anæsthetic or the aspiration of foreign substances during inhalation anæsthesia probably plays a part in the production of postoperative bronchitis and pneumonia. However, the fact that these complications, with great frequency, following spinal and even local infiltration anæsthesia suggests that other factors play an equally important part.

6. Pulmonary complications have their highest incidence in the winter months (December, January, and February) and are far more common in patients of advanced years.

7. In the light of our present knowledge, treatment of these conditions should consist of (1) hyperventilation during and after operation with carbon dioxide and oxygen, as advocated by Scott and Cutler; (2) change in the position of the patient every 6 hours, after operation (Sante); (3) curtailment of sedatives after operation, especially those which depress the cough reflex, and when collapse occurs, the bronchoscopic removal of the mucus or, whenever the other complications considered are present, the use of our newest and most valuable aid, the oxygen tent.

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THE BLOOD SUPPLY OF THE HUMAN PARATHYROIDS[1]

GEORGE M. CURTIS, M.D., F.A.C.S., CHICAGO
Department of Surgery, University of Chicago

THE preservation of the function of the parathyroids during the course of operations upon the thyroid gland, calls for a knowledge not only of their location but also of their blood supply. The prevention of tetany necessitates first, that a sufficient number of the glandules be spared, also that those remaining shall have an intact blood supply.

The parathyroids lie, as a rule, in a zone along the posteromedial surfaces of the thyroid lobes. This "danger zone" is well recognized and, thanks also to the position of the adjacent recurrent nerves, a sufficient number of parathyroids is usually spared in subtotal resections of the lobes. However, variations from this usual position occur, and it is particularly these aberrant glandules which are likely to be removed. Wellbrock found that about 8 per cent of 1,056 thyroid glands removed at the Mayo Clinic revealed parathyroids. It thus becomes of increasing importance to maintain an intact blood supply to the glandules which remain.

Since the studies of Welsh and later of Halsted and Evans (13), which have been abundantly confirmed, it has been generally recognized that the parathyroids receive their blood supply principally from the inferior thyroid arteries. From this anatomical fact it would seem that these arteries should be carefully preserved during operations upon the thyroid gland. This view has actually been expressed, more recently by Dunhill. However, as a matter of clinical experience bilateral ligature of the inferior thyroid arteries, or for that matter of all four thyroid arteries (7, 8, 17), is but rarely followed by tetany (2).

The solution of this apparent inconsistency lies in the abundant collateral vessels between the inferior thyroid arteries and those of the larynx, pharynx, trachea, and œsophagus, as well as the anastomoses with the superior arteries. It is through these collaterals that blood is assumed to reach the parathyroids even after ligature of all four of the main afferent trunks. In this study, we have experimentally examined the basis for this assumption by means of injections of the thyroid region before and after ligature of the thyroid arteries (5).

APPARATUS AND METHODS

An especially designed pressure apparatus was employed in making the injections (5). The majority of the injections were made with a thin, carmine-gelatin mixture, which remains fluid at ordinary temperatures (15). The viscosity of this fluid is less than that of the thicker mass, consequently it passes into the capillaries more readily under ordinary temperatures and pressures. The injection pressure was ordinarily 150 millimeters of mercury.

In preparing a cadaver for injection, two effects were sought. *First*, to insure the injection of all those vessels giving collateral branches to the thyroid region. *Second*, to confine the injection mixture largely to this region. The first was accomplished by injection into the lower thoracic or upper abdominal aorta. The second was effected by bilateral ligature of those unnecessary arteries leading away from the cervical region, particularly the second division of the subclavian, the internal carotid, the terminal portion of the external carotid, the vertebral, and the internal mammary.

The larynx, pharynx, trachea, and œsophagus are firmly bound together in the neck by the deep cervical fascia. As a consequence the arteries to the upper respiratory and digestive tubes have common origins. The œsophageal and bronchial arteries bring blood to these regions from the upper thoracic aorta below. To conserve this supply the injections were made below the origin of these arteries.

POSITION OF THE PARATHYROIDS

The position of the parathyroids is of the greatest importance in any consideration of

[1] From the Surgical Clinic of the University of Berne, Prof. F. de Quervain, Director. Read before the Chicago Surgical Society, February 7, 1930.

their collateral blood supply. Consequently, they were identified and examined in 12 cadavers, by dissection. The small brownish bodies of varying shape and size were first located, then removed and proved to be parathyroids by making frozen sections of the glandules. All four parathyroids were found in 11 cadavers. In 1, the left superior parathyroid could not be located. The glandules vary in size, shape, and even in color. They may conceivably be confused with small lobules of fat, with accessory nodules of thyroid tissue, or even with lymph glands (11). Such uncertainty was quickly dispelled in this study, however, by an examination of frozen sections. One inferior parathyroid was found embedded in the substance of the thyroid gland, immediately beneath the thyroid capsule.

Accessory parathyroids have recently received renewed attention, particularly in relation to resected thyroid lobes (16, 18, 19). At the time this study was made no particular search was made for these on the frank anterior surfaces of the thyroid lobes. However, one aberrant gland was found on the anterolateral surface of the left lobe.

The majority of the parathyroids lie between the thyroid fascia and the thyroid capsule, within the thyroid space (3), in a zone between the thyroid, trachea, and œsophagus. In this situation they are in intimate relationship with the anastomotic vessels between the thyroid arteries and those of the respiratory and digestive tubes. Collateral vessels between these structures and their enveloping fasciæ pass through this zone, and the parathyroid arteries may even arise from them (8, 9, 10, 13, 17). A knowledge of this position and relationship, recognized by Halsted (12) on the basis of MacCallum's dissections, and designated by de Quervain the "*danger zone*," is of manifest importance in preserving the parathyroids as well as their collateral blood supply during subtotal thyroidectomy.

NORMAL BLOOD SUPPLY OF THE PARATHYROIDS

In 8 bodies the injections were made, previous to a necropsy, without any preliminary ligature of the thyroid arteries. The parathyroid area was then dissected and its blood supply examined. Our findings regarding the actual blood vessels to the parathyroids are in most respects similar to those of Halsted and Evans (13). These have been confirmed by many (1, 14). The glandules receive a single artery of variable length which enters at the hilum, and courses within the center of the glandule (20). There are no visible anastomoses between the gland sheath and the surrounding connective tissue. The inferior parathyroid arteries arise from the inferior thyroid artery. They may arise from the main subdivisions, or from any of the terminal branches. In 2 cases they arose from the inferior laryngeal artery, on its way to the larynx. In 3 cases they arose from branches which farther in their course penetrated the œsophageal wall. A similar origin from these anastomotic vessels has been frequently observed, and figured. They also arise from a posterior anastomotic "channel" between the superior and inferior arteries. In 1 cadaver the left inferior thyroid artery was absent, and the left inferior parathyroid artery arose from a continuation of the posterior branch of the superior thyroid artery. The arteries may also arise from branches destined to form an anastomosis with vessels of the opposite side, particularly behind the isthmus.

The superior parathyroid arteries arise commonly from terminal branches of the inferior thyroid arteries. In 2 cases these terminal branches were farther traced into the wall of the œsophagus. They may also arise from the anastomotic "channel" (13) connecting the two thyroid arteries. In unusual cases they arise from branches of the posterior or medial divisions of the superior thyroid arteries. Ginsberg (10) has figured such an instance. The parathyroid arteries are readily recognized. They may be as long as 2 centimeters.

The important collateral blood supply connecting the branches from which the parathyroid arteries arise with the arteries of the larynx, pharynx, trachea, œsophagus, and the adjacent cervical fasciæ, is surprisingly abundant. Connecting vessels may be readily traced to these structures. Terminal branches of both thyroid arteries anastomose across the isthmus, and behind the isthmus with tracheal

vessels. The larger collateral vessels below, from the inferior arteries, are the inferior laryngeal, the œsophageal, and tracheal branches, and those to the isthmus. Above, in addition, from the superior arteries, are the superior laryngeal, pharyngeal, and muscular branches and the cricothyroid arteries. There is also a free anastomosis between the two thyroid arteries, particularly on the posterior surface of the gland, but to a certain extent also within its substance.

EXPERIMENTAL DEMONSTRATION OF THE ABUNDANT COLLATERAL VESSELS

We have observed that the blood supply to the parathyroid glands arises, in nearly all instances, from the inferior thyroid arteries. This is in accord with the observations of many others. In the technique of thyroidectomy, particularly as developed by de Quervain (3), these two arteries are frequently ligated by a preliminary well planned procedure (4). This procedure is very rarely followed by even a mild, transient tetany, hence it appears clinically that the glands have an adequate collateral blood supply. Following the principles as developed by Petenkoffer, Enderlen and Hotz, we have studied this question experimentally by first ligating both inferior thyroid arteries in the customary manner of the clinic (4), making the injection as described, and finally examining the parathyroids microscopically for the presence of the injection mixture. Two bodies were thus successfully injected.

After preliminary ligation of the unnecessary arteries, the inferior thyroid arteries were exposed extracapsularly, between the common carotid and the thyroid gland (4). They were then ligated at the commencement of the horizontal portion, in order to insure ligature of the main trunk. Injections were made and the parathyroids located, removed, and sectioned. Not all the injections attempted were successful. However, in two bodies it was possible to demonstrate the presence of the injection mixture in the parathyroid glands, when these were frozen, cut, and examined. In one body the ligated inferior arteries, lying on the posterior surface of the thyroid, were well injected up to the point of ligature.

We have recorded the number of arteries ligated, preliminary to thyroidectomy, in 270 consecutive operations performed in the Berne Clinic between October 1, 1925, and December 31, 1926. These cases were carefully followed. The data have been presented (5). In 40 per cent three arteries were ligated. The ligature of three arteries is usually of both inferiors and the anterior divisions of both superiors. All four arteries were ligated in less than 1 per cent of the cases, and the average number of arteries ligated per operation was but 2.28.

Since in this series the preliminary ligature of three arteries was the most frequent procedure, it was attempted in 5 bodies preliminary to the injections. Both inferior thyroid arteries were ligated as usual (4). The anterior branches of both superior arteries were ligated by forcing a threaded aneurism needle through the anterior half of the superior pole of the thyroid gland and ligating this with its attached vessels. An attempt was made to spare the posterior division, passing along the posterior or posteromedial surface of the lobe. After the injections carmine gelatin was evident microscopically in the parathyroid sinusoids in 3 of the 5 bodies. In 2 bodies the injection was unsatisfactory owing to technical difficulties. In the 3 bodies it was also possible to demonstrate the injection mixture within the posterior portions of both thyroid lobes in the parathyroid region.

In 2 bodies three of the four arterial trunks were first ligated, and the collateral circulation to the parathyroids again tested by making the usual injection. The two inferior arteries were ligated as usual and the left superior artery was tied at the superior pole. Considerable injection mixture was found in the right upper lobe, and below, since the right superior artery was left patent. However, the mixture was also demonstrable in the left lobe. In both bodies frozen sections revealed the presence of the carmine stained mass within the parathyroid sinusoids. In one body three of the glandules contained visible amounts of carmine gelatin.

As a final test all four thyroid arteries were ligated in 3 cadavers preparatory to making the usual injection. The two inferior arteries

were ligated as usual. The two superior arteries were ligated just above the gland substance. The injections were made with a hot, thin mixture and were considerably prolonged at sufficient pressure to insure the possibility of filling all collaterals. The cervical viscera were then removed *in toto*, and the parathyroids located, removed, and examined microscopically. Thyroid tissue was also removed from nearby each pole, in the posterior subcapsular region, and examined microscopically.

It was possible to demonstrate microscopically the carmine-gelatin mixture in the majority of the parathyroids, and also in the excised pieces of thyroid tissue. In one body carmine gelatin was definitely visible in the sinusoids in two of the parathyroids. In the third, the right inferior parathyroid, there was but a moderate amount of the colored mixture. In the fourth, the left inferior glandule, there was so slight an amount evident that its presence might be questioned. The four subcapsular pieces of thyroid tissue revealed a moderate amount of the carmine-gelatin mixture in all save one piece, that from the right lower lobe. No thyreoidea ima artery was present.

The collateral supply in these cases is clearly from the arteries of the digestive and respiratory tubes. Above, the larynx is supplied by the hyoid branches of the lingual arteries, the superior laryngeal branches from the trunks of the superior thyroid arteries, and muscular branches including the cricothyroid arteries. The latter may be cut off by the ligature at the superior pole. From below come the bronchial arteries anastomosing with those of the trachea. The pharynx, above, receives branches from the first portion of the superior thyroids and the ascending pharyngeal arteries. From below come the œsophageal arteries. About the viscera are small vessels in the deep cervical fasciæ. Blood can thus pass particularly from the trachea and œsophagus through abundant anastomoses back into the thyroid arteries.

SUMMARY

The blood supply to the human parathyroids, particularly the collateral blood supply, was studied in a series of 25 cadavers immediately preceding necropsy. An especially devised injection apparatus was employed. A carmine-gelatin mass was injected into the lower thoracic aorta, below the origin of the bronchial and œsophageal arteries, at a pressure of 150 millimeters of mercury. By preliminary ligature of unnecessary arteries leading away from the neck, the injection was localized largely to the thyroid area. Abundant anastomoses were demonstrated between the thyroid arteries, especially the inferior, and the arteries of the larynx, pharynx, trachea, œsophagus, and their surrounding fasciæ. The thyroid arteries also anastomose with one another and across the median line, particularly in the region of the isthmus. The parathyroids receive their single artery as a rule from the inferior arteries.

After preliminary ligation of both inferior thyroid arteries, the presence of carmine gelatin was demonstrated in the parathyroids after injections, by means of frozen sections. After ligature of both inferior thyroid arteries, together with the anterior branches of both superior thyroid arteries, the injection mass was demonstrated in the parathyroids by the same method. In 3 bodies all four arterial trunks were ligated preliminary to the injections. The mixture was subsequently demonstrated in the vascular spaces of the parathyroids. The fascial connections posteriorly between the thyroid and the trachea and œsophagus, particularly in the region of the isthmus and the medial borders of both lobes, are important in maintaining this collateral supply.

In the Surgical Clinic in Berne it is a frequent procedure to ligate both inferior thyroid arteries as a hæmostatic measure preliminary to a thyroidectomy. In many instances the anterior branches of the superior arteries are ligated at the same time. In less than 1 per cent of the cases all four of the arterial trunks are ligated. Since tetany does not follow these procedures it is apparent, from extensive clinical evidence, that the collateral blood supply to the parathyroids is ample. The demonstration of injection mixture in the parathyroid glands following the preliminary ligature of both inferior thyroid arteries, and

even of all four thyroid arteries, substantiates this conclusion and places it on a firm experimental basis.

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ROENTGENOLOGY OF THE APPENDIX[1]

JOSEPH W. LARIMORE, M.D., St. Louis, Missouri

THE contribution of roentgenology to the diagnosis of chronic appendicitis is often disparaged [Bettman, Carnett and Boles, and Deaver (6)]. This occurs in spite of the obvious fact that correction of the adverse percentage of results for the operation for chronic appendicitis demands more certain diagnosis. The help given by roentgenology must generally be poorly understood by clinicians to be thus rejected when more help for accurate diagnosis is needed. It is unfortunate that one author should say, "the main cause of needless appendectomies is the *furor operandi* of ambitious surgeons. Their chief aid and abettor is the roentgenologist. In no other department of roentgenology is there so much confusion and misunderstanding." Rohdenberg calls attention to the fact that chronic or productive changes do not markedly increase the liability of the appendix to fall a prey to severe acute inflammation. It cannot be claimed that the roentgenogram with the related roentgenological findings will make the diagnosis, but in most cases roentgenology will contribute facts of great value to the final diagnosis. To this end the roentgenological data must always be considered together with the clinical findings. The diagnosis of chronic appendicitis is incomplete, the one without the other. Without debating the term, "chronic appendicitis," it is used in this article in the broadest sense as including all cases which are not so acute as to preclude roentgenology.

The failures of operation for chronic appendicitis have not all been complete failures. Associated disease, undiagnosed and untreated, has often caused an incomplete clinical result. Roentgenology will also serve in establishing concurrent alimentary disease. Therefore, roentgenology of the appendix should not be practiced separately, but as part of a complete and general roentgenological gastro-intestinal examination. This will include cholecystography. This increases inestimably the value of the whole examination by its demonstration of the functional status of the gall bladder, which may thereby be established as part of, or eliminated from, the clinical problem. Elsewhere (10), it is shown that ulcer and cholecystitis are with great frequency associated with and sequel to chronic appendiceal disease, especially where the appendectomy has been delayed beyond the usual early age period (15 to 25) of unassociated appendicitis. Solieri calls the frequent association of appendicitis, peptic ulcer, and cholecystitis, "the pathological harmony of the right abdomen" and is convinced they are connected by a pathogenetic bond. Chronic appendicitis frequently creates a clinical syndrome simulating duodenal ulcer, which can be differentiated only by gastro-intestinal roentgenology.

There are relatively few occasions in the broad field of diagnostic roentgenology when the roentgenological evidence can alone complete the diagnosis or give the indications for treatment. This evidence, as a general rule, should not be given an independent responsibility for a final diagnosis. The abuse of this principle rests more often with the physician than with the roentgenologist.

In 1925, the roentgenological signs of a pathologically altered appendix were clearly presented by White. Since then certain very helpful signs have been developed and experience has further proved the value of the signs and shown the association of appendiceal disease with the other abdominal conditions. The significance of visualization or of non-visualization has been debated far beyond the value of the point involved and in the face of an obvious need for accessory data to give weight to either status. The statistics of visualization by different observers has ranged from 10 per cent to 100 per cent. The failure of the appendix to be visualized upon repeated examination can be only suggestive of disease. The normal appendix is visualized only by the opportune coincidence of its filled condition to the roentgenographic or fluoroscopic observation. Non-visualization never necessarily means an occluded and non-fillable

[1] From the Departments of Radiology and Medicine, Washington University Medical School, St. Louis, Missouri.

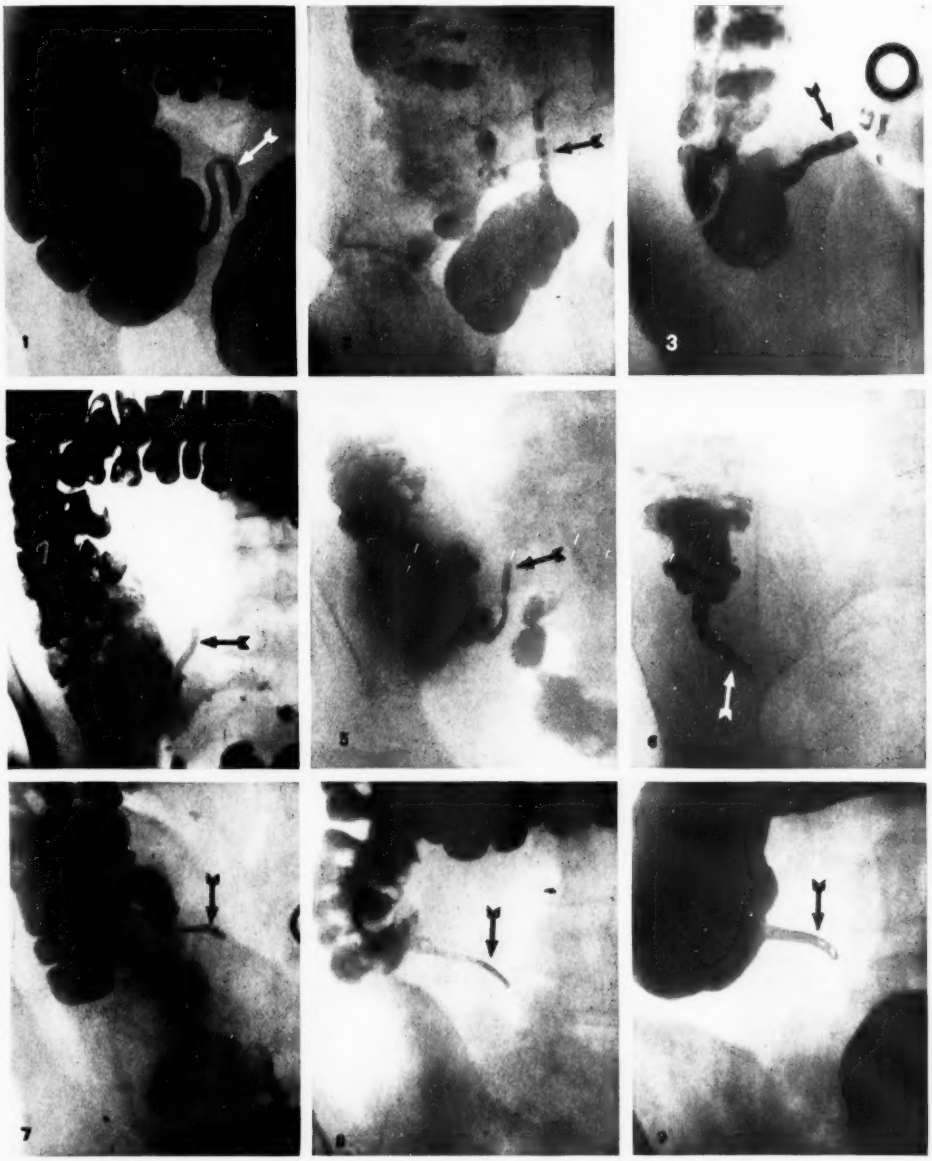

Fig. 1. The rigid appendix contrasted with the normal appendix. *1*, The normal appendix as homogeneously filled by the barium enema. The lumen is fairly uniform. It is free floating among the intestines, readily moved by palpation, and without tenderness. *2, 3, 4, 5, and 6*, The appendix is persistently rigid indicating a gross infiltration of the walls and is accompanied by a motor impairment (stasis) in spite of an open lumen. Cæcal stasis, as shown, usually accompanies this. *7, 8, and 9*, The appendix, observed in the same case on three different occasions, maintains its relative and fixed position.

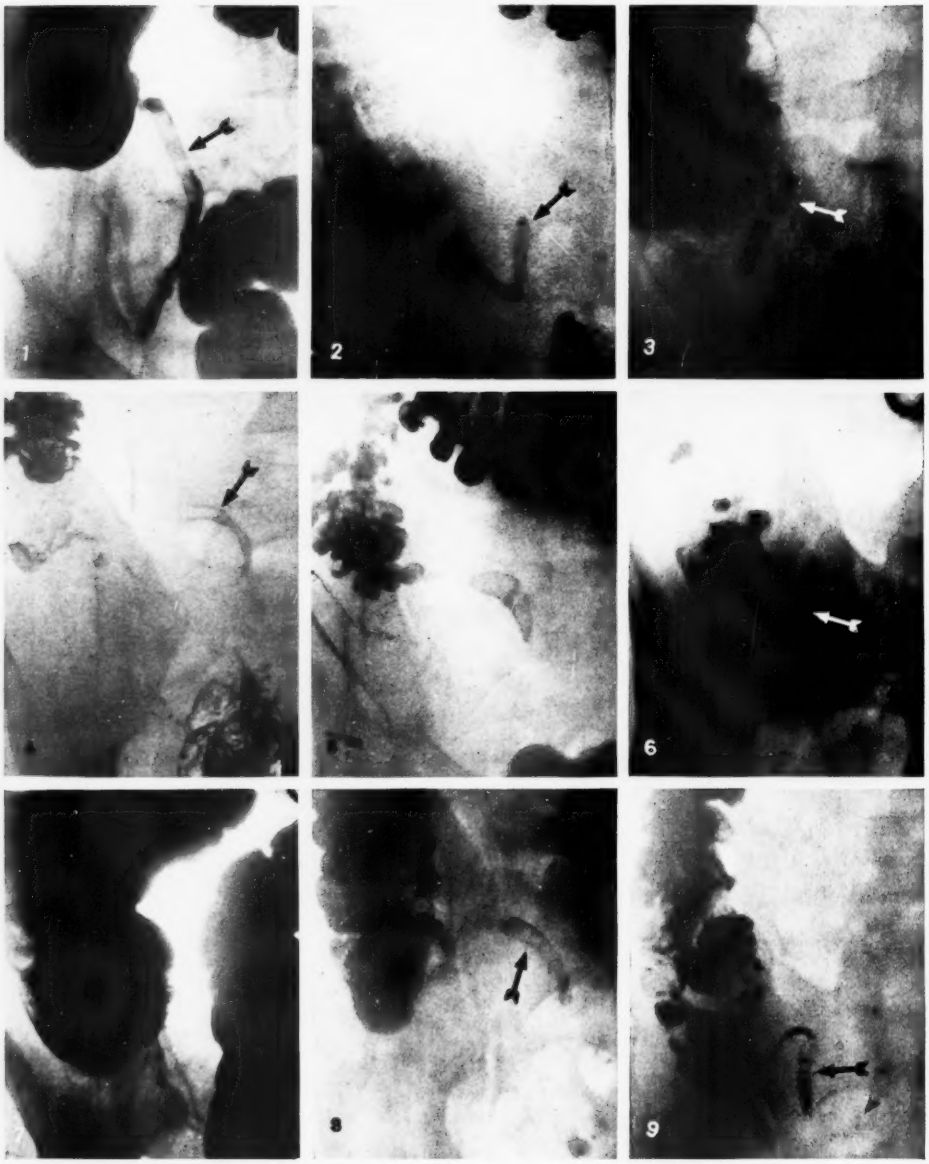

Fig. 2. Dilatation of the appendix. *1, 2, and 3,* Uniform dilatation of the lumen from increased intracæcal tension. *4 to 9,* Dilatation, tending to cystic distention, of the lumen distally because of proximal partial occlusion.

appendix. The normal appendix can and does empty itself very shortly after the cæcum has emptied. The force of the peristaltic waves in the appendix has been demonstrated in the experimental animal (7), and the peristalsis observed in the appendix of man, leads to the conclusion that the normal human appendix has a vigorous motility. It may conceivably

Fig. 3. Retained concretions. These are shown by defects ("holes" or "vacuoles") in the barium shadow of the appendix lumen.

have emptied itself of barium prior to even repeated roentgenograms. Only when well supported by the secondary signs described later does non-visualization upon repeated observation gain the significance of pathological occlusion. And visualization gives evidence of pathology only by revealing an altered structure. The accompanying table

Fig. 4. Obliterative narrowing of the lumen by changes in the walls of the appendix. *1, 2, and 3,* Appendices with the lumen fairly uniformly narrowed. *4,* The appendix is almost obliterated with only a thread line lumen persisting. *5,* The appendix is almost obliterated excepting for a bulbous tip which retains a concretion. *6,* Localized obliterative change in the wall producing a constriction of proximal portion and marked stasis distally. *7.* Narrowing of the lumen distally with slightly bulbous tip and retained fæcoliths. The proximal half is slightly dilated. The cæcum shows a motor delay. *8,* Localized constriction occurring in two places. The cæcum shows a motor delay. *9,* Proximal constriction with distal dilation and retained fæcoliths. The cæcum shows a motor delay.

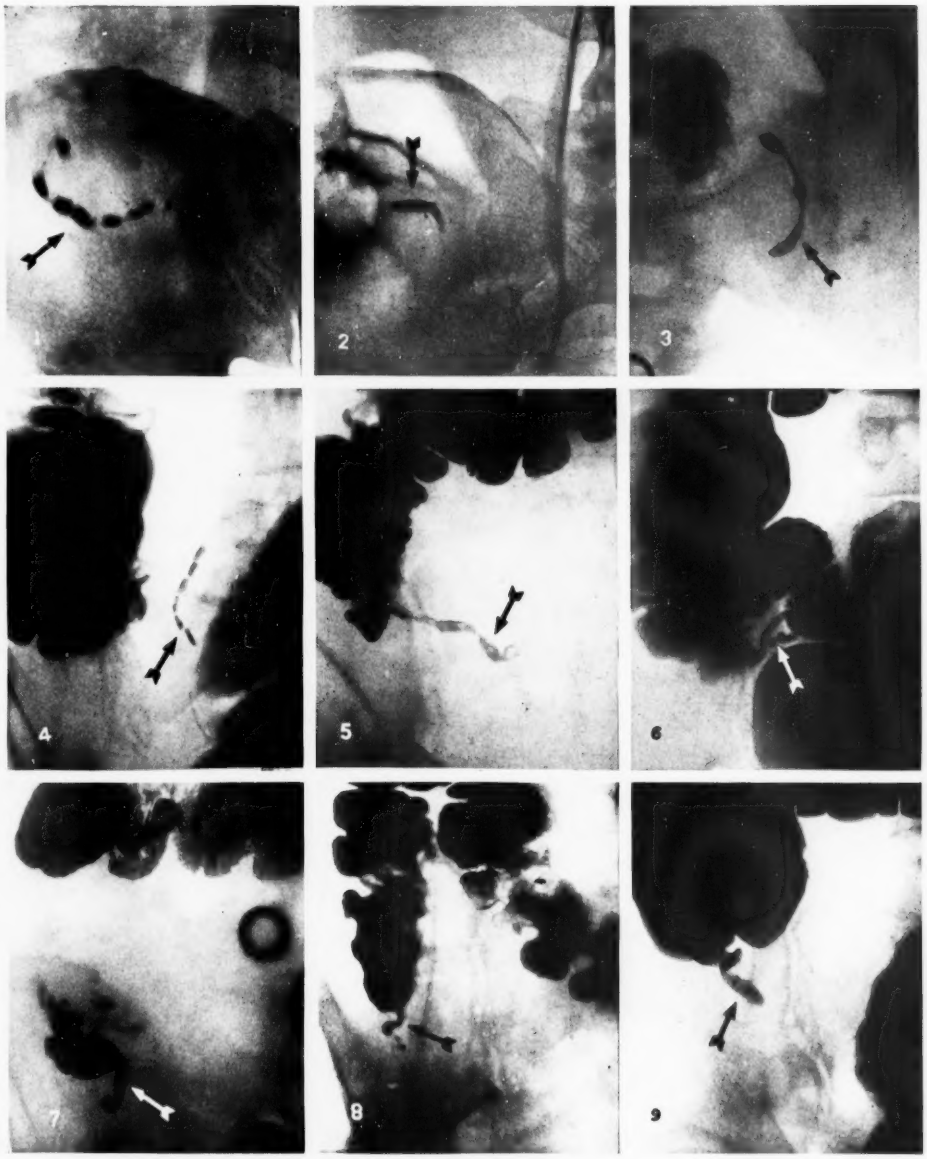

Fig. 5. Impaired motility of the appendix (appendostasis). *1*, After 4 weeks barium remains in the appendix. *2*, After 4 days barium is found in the appendix, on the occasion of an urological examination. *3*, Peristalsis is unable to empty the appendix. *4*, Beaded barium at the 24 hour observation. *5*, Barium residue outlining the lumen which retains non-bariumized content. *6*, Barium remaining in the appendix from the fed test at the time of a barium enema. *7*, The appendix filled and deformed with associated stasis in the cæcum; the ascending colon has emptied. This suggests an associated typhlitis. *8*, The filled appendix fixed in a coiled shape below the cæcum, which shape and relative position is retained in the barium enema observation. *9*, The same appendix filled by the barium enema and showing by the darker portions of the shadow the barium which remained from the fed test.

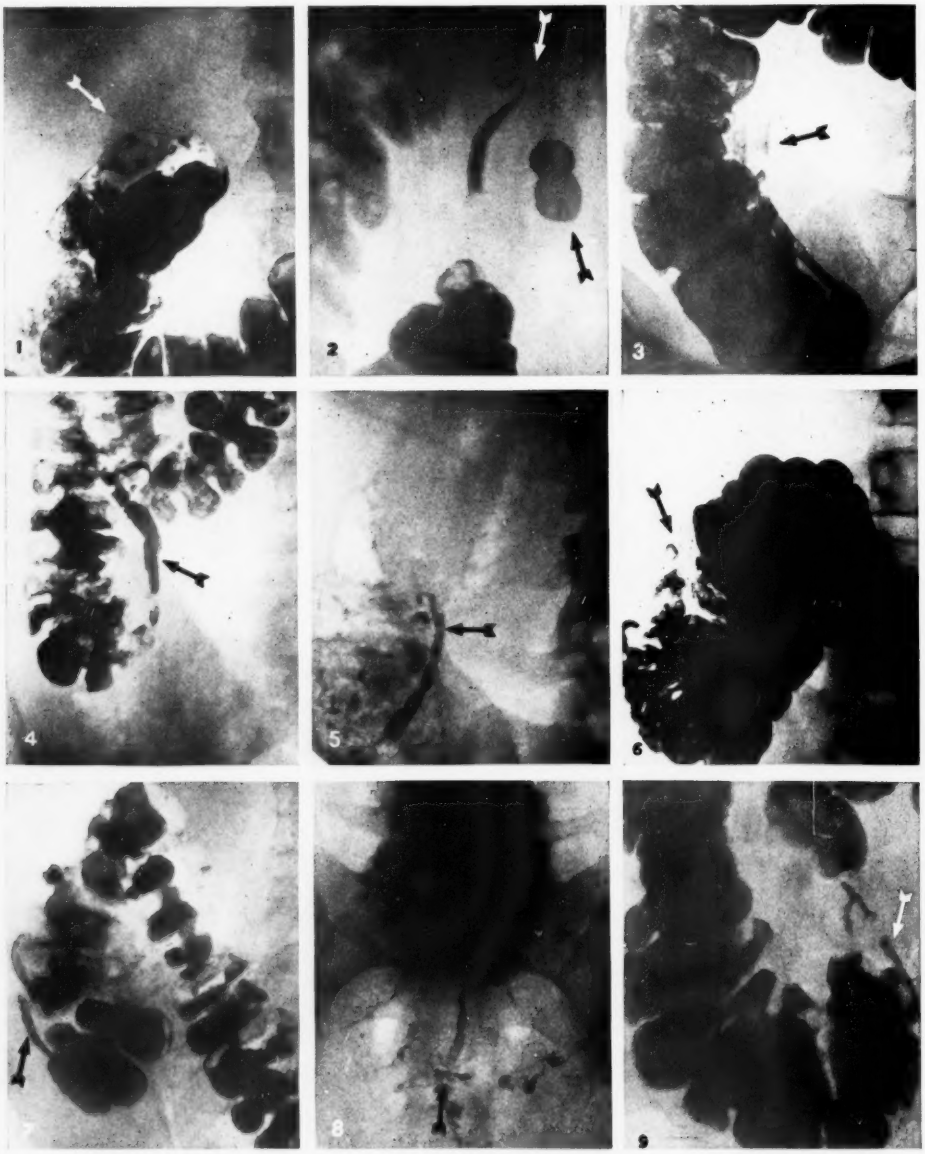

Fig. 6. The ectopic appendix: *1*, Infrahepatic by reason of a congenitally non-descended and fixed inverted cæcum (the cholecystographic shadow shows the gall bladder in the background). *2*, Infrahepatic by reason of a cæcum mobile (two gall stones orient the gall bladder). This appendix was found in the pelvis at another observation. *3*, Retrocæcal, folded and fixed in an acquired position behind the left border of the ascending colon and cæcum. *4*, Retrocæcal with tip kinked and fixed behind the ascending colon. *5*, A condition similar to *4*. *6*, Lying at the right abdominal parietes by reason of the cæcum being inverted to right and fixed. *7*, A condition similar to *6*. *8*, Midline pelvic position by reason of the anomalous and fixed position of the cæcum over the promontory of the sacrum. *9*, Left pelvic position by reason of hyperrotation and migration of the cæcum into the left pelvis.

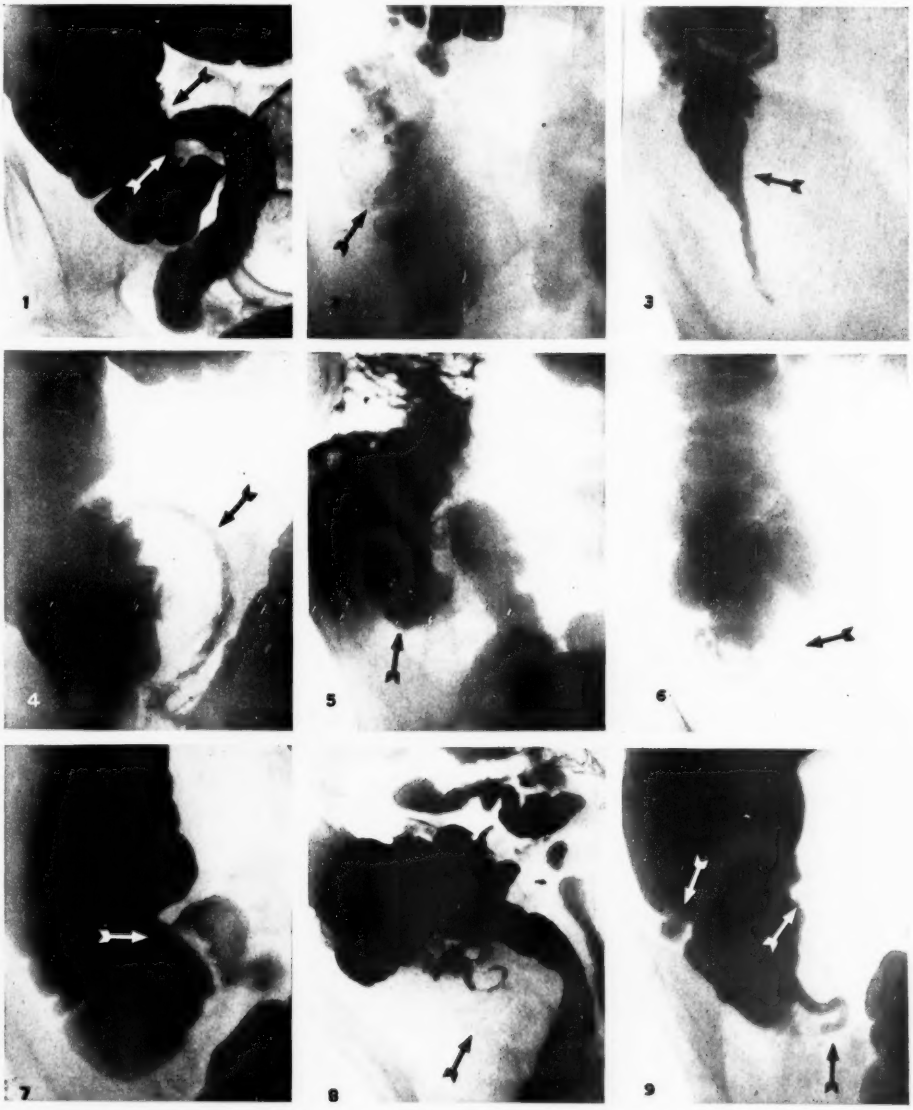

Fig. 7. Conditions requiring differential diagnosis from appendicitis. *1*, Secondary ulcerative tuberculosis of the ileocæcal valve and adjacent mucosa. *2*, Simple typhlitis causing a localized segmental hypermotility. Tenderness was diffuse over the cæcum. The appendix was not visualized. *3*, Simple typhlitis which has progressed to cause impaired motility of the terminal cæcum and appendix, which shares in the irritation. The appendix is of the embryonic type. *4*, Typhlitis and ileitis resulting in a palpable tumefaction. Resection of the cæcum and terminal ileum was done with no findings indicating a specific etiology. *5*, Ulcerative ileocæcal tuberculosis secondary to pulmonary tuberculosis, more extensive and advanced than that shown in *1*. *6*, Deformity of the cæcum resulting from palpable cancer. *7*, The ileocæcal valve is incompetent in presence of good cæcal tonus, indicating other than a functional cause for the failure of the valve. *8*, Deformity of the cæcum and displacement of the terminal ileum by a peri-appendiceal abscess, which had been present 2 months. *9*, Two diverticula of the cæcum, introducing the necessity for differential consideration between a diverticulitis and an active appendicitis.

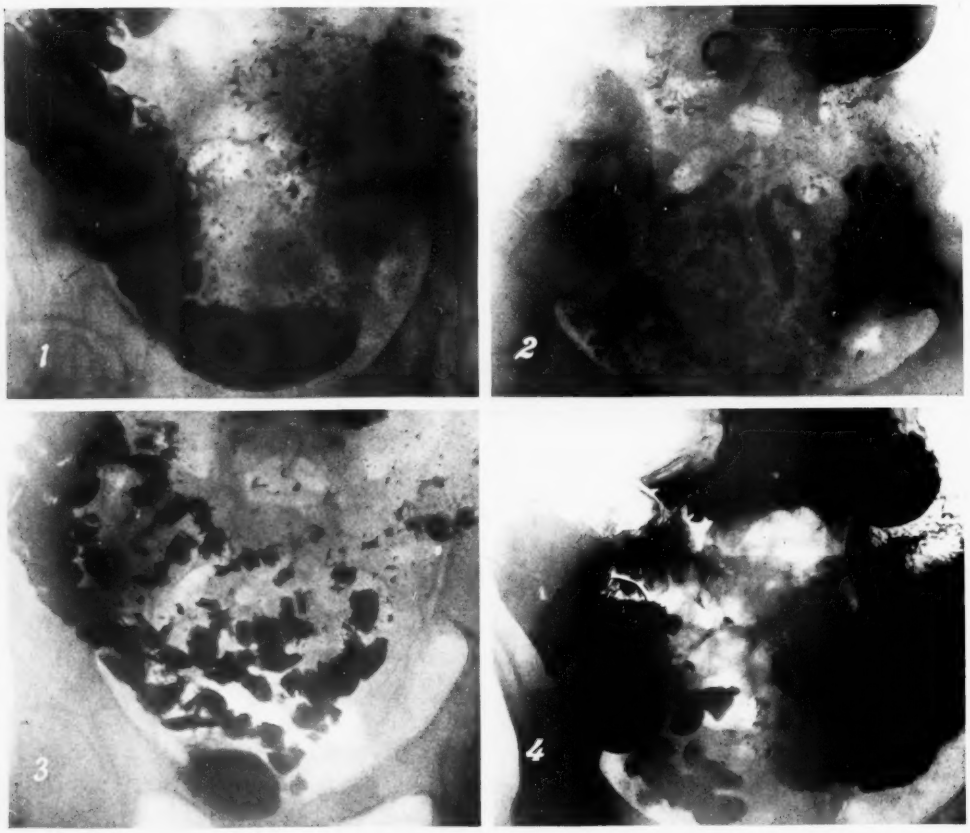

Fig. 8. The irritation pattern of the small intestine in the vertical film taken at the 6-hour period. *1*, The usual or normal picture of barium in the small intestine at 6 hours after ingestion, appearing as a homogenous density in the ileum and as feathered remnants in the jejunum. *2*, The barium appears in small discrete patches throughout the small intestine as the result of intermittent gastric clearance due to partial pyloric stenosis from ulcer. *3*, The barium appears in gross discrete patches throughout the small intestine as the result of the effect of a peritoneal change from pelvic inflammatory disease. Such a picture varying in definiteness may result from past or present peritoneal irritation ranging in degree from congestion to peritonitis. *4*, The irritation pattern of discrete patches of barium is localized in this picture to the terminal ileum in the region of the appendix. This gives presumption to its origin from appendiceal inflammation.

shows the findings with the appendix in a series of 4,049 complete gastro-intestinal roentgenological examinations. Significant appendiceal findings occurred almost five times as often with visualization as without visualization, and 50 per cent of the visualized appendices had associated signs of pathology, while, with only 5.3 per cent of instances of non-visualization were there associated findings of conclusive significance. Visualization of the appendix has often been demonstrated a few hours after a barium enema, when it was not visualized in the fed test. The more uniform distribution of the intracæcal tension by the fluidity of the enema allows for easier percolation into the appendix. The post-enema appendix film is routinely included in the examination.

Structural changes of the appendix will be revealed by its barium filled lumen. Pathological form of the lumen is a dependable finding. Strictures, filiform reduction of the

lumen, stiffening of the wall, and bulbous distention, which may become cystic dilatation, are pathognomonic of anatomical change. That the demonstration of these anatomical changes in the appendix in the adult is evidence only of involution is not tenable. But these changes alone are not conclusive of clinical appendicitis. They may be residual only.

Abnormal position of the appendix may be casual or fixed and when fixed may be of congenital or acquired origin. The congenitally abnormal fixed position is usually retrocæcal. It is a basis for anatomical pathological change. The acquired fixed position is the result of inflammatory penetration of the wall of the appendix producing adhesion to the adjacent structures which may cause absolute fixation to the parietes, or relative fixation to the cæcum and ilium with which it then shares in mobility and to which it maintains its relative position. The retrocæcal position of the appendix is important because it varies the clinical picture and complicates surgical interference. It is usually congenital and occurs by hyperrotation and descent of the cæcum. Its fixation is more often acquired.

The impairment of the motility of the appendix is shown by the retention of barium after the cæcum has emptied. This may be protracted. It is more significant when the motility of the appendix is delayed at 24 hours with the right colon emptied than if delay at 72 hours occurs with cæcal and right colonic stasis. Instances are seen in which barium has remained in the appendix for weeks. Retained non-opaque fæcal masses (stercoliths, fæcoliths, or concretions) are revealed by infiltration of barium about them within the lumen. They appear as vacuoles or holes in the barium. It can be conceived that such retained material may occlude the appendix to any filling with barium and that this may account for non-visualization. Concretions are an expression of a previous or co-existent inflammatory process and are not themselves the exciting cause of the initial inflammation. The facility with which the unchanged appendix energetically empties itself in experimental observations lends support to the premise that retained concretions occur and persist because of chronic motor impairment. That concretions may subsequently be a factor in the origin of acute disease is shown by surgical experiences. Archibald found 22 in 41 cases of perforation and 3 in 38 non-perforation cases. Bowen noted concretions in 80 per cent of abscessing or gangrenous appendices and in only 9 per cent of catarrhal appendices. Deaver (5) found a fæcolith in 22.3 per cent of 120 acute cases.

The deformity of the appendix, often described as a "kink" is most difficult to determine. Projection of curves upon the plane picture of the film will simulate them. They cannot be asserted in any case unless other changes are concomitant. Actual fixation of the deformity should be determined together with the resultant changes in the distal lumen, motor impairment, and dilatation.

The topographical position of the appendix has wide variations, although usually it extends to the left and below the ileocæcal juncture near the classical McBurney's point. It may, however, radiate in any direction from this point. Roentgenology has shown the inconstancy of McBurney's point for the appendix and has disproved the validity of that point for its certain palpation. The rotation of the cæcum and its migration vary greatly. These variations are congenital as shown by studies upon the new born (9). The topographical level or the height of the viscera in the abdomen varies also according to bodily habitus. The normal position of the cæcum is given a wide vertical range by these several factors. In addition, it may be in such wholly anomalous positions as the infrahepatic, midline, or the left pelvic. Physical diagnosis has not yet given proper attention to these variable positions of the appendix which force upon many of the maneuvers of palpation a reservation as to their reliability. In the low pelvic cæcum of the congenital ptosis of the asthenic bodily habitus, the relative position of the appendix to the cæcum will be as usual, and, when filled, it may be seen to the left of the cæcum unless obscured by the adjacent rectum. The appendix will have a semi-retrocæcal position to that cæcum which has taken a pelvic position because the right colonic segment has an increased length.

This topography results from congenital hyperrotation of the colon. The appendix in this position may often only be seen and roentgenographed with the patient turned in a manner to present a left anterior view. Hyperrotation of the colon may even turn the appendix to the right of the cæcum.

The foregoing presents the variations of the appendix as shown by roentgenograms. These details are much better seen in good films than by fluoroscopy. It is not, therefore, debatable that fluoroscopy alone is adequate for diagnostic observation of the appendix. Fluoroscopy supplements the roentgenographic observations and is indispensable. It directly attaches the clinical attributes to the physical pathology. Fixation of the appendix and of the cæcum may better be determined and the non-roentgenological sign of tenderness may best be investigated. Many of the maneuvers of palpation in physical diagnosis are predicated upon McBurney's point for the topographical position of the appendix, yet it departs from this point in 13.5 per cent of persons even in the recumbent position (9). Tenderness is not present with palpation of the normal appendix. Its occurrence indicates an abnormal sensitiveness of the organ. To be characteristic, this tenderness is localized or centered to the origin of the appendix from the cæcum, and this point of greatest tenderness follows displacements of the cæcum. As a corollary, it can be shown to be absent from where the cæcum and appendix are displaced. A similar tenderness to pressure should not occur in the left abdomen unless other coincident disease is present, usually diverticulitis, or a simple spastic and palpable sigmoid. Palpable tenderness of the appendix is often referred to the umbilicus or to the epigastrium and is frequently subjectively noted by the patient wholly in those ectopic positions. The tenderness of the lumbar spine resulting from spinal malstatics, of which lordosis is common, is the most frequent of lower mid-abdominal palpable tenderness and must be differentiated. Tenderness of the spine to palpation may even be unilateral and along the right margin of the vertebræ. Pain localized to the sacro-iliac articulation may be more confusing, although it occurs less frequently. It is not the place here to discuss the significance of tenderness found elsewhere than at the appendix and cæcum, but such other tenderness is of value in solving the problem of a syndrome which has clinically suggested appendicitis. The evaluation of hypersensitiveness of the right abdominal wall is greatly aided by fluoroscopic palpation of the barium ized cæcum and appendix. Tenderness due to and localized to other abdominal disease can be demonstrated as not localizing to the appendix. The filled cæcum, especially when retaining the inspissated material of stasis can be very tender, and this tenderness perforce follows displacements of the cæcum. Typhlitis, simple and catarrhal in type, often accompanies a pathological appendix and may be more significant to the clinical syndrome than the altered appendix. Also the failure to correct a residual typhlitis will spoil the clinical result of many valid appendectomies. By typhlitis is meant a chronic, afebrile, more or less painful condition of the ileocæcal region. It may be part of a more extensive colitis. It may occur without a demonstrably altered appendix and may itself wholly account for the clinical syndrome. The feathery contour of the enema (barium) filled cæcum evidences the mucus which characterizes the condition. When advanced there will be an accelerated motility to the cæcum due to its more irritable condition. The motility of any segment of the alimentary tract can be judged only with knowledge of the motility of the proximal and distal segments. The relation of ileal motility to colitis has been developed by Kantor. He shows that a functional defense reaction of spasm of the ileocæcal sphincter occurs.

Shortly before White presented the roentgenological attributes of the appendix, Mills described the roentgenographic pattern of the small intestine which indicates a past or coincidental peritoneal irritation. These are atypical, patchy, irregular, discrete loops of small intestine and they vary in definition according to the degree of the original disturbance which may be conceived as ranging from a congestion of the peritoneum to a peritonitis. Mills asserted these irritation forms to be roentgenological evidence of the

SUMMARY OF APPENDIX X-RAY DIAGNOSIS IN FOUR-THOUSAND AND FORTY-NINE CASES WITH THIRTY-FOUR AND TWO-TENTHS PER CENT VISUALIZATION

	Visualized	Non-visualized	Total
Appendicitis*	7	20	27
Pathological appendix			
Quiescent†	272	0	272
Irritable‡	227	0	227
Irritable appendix§	207	114	321
Indeterminate findings¶	668	0	668
Totals	1381	134	1515

*Sub-acute inflammatory disease, or localized peri-appendiceal abscesses with a pericæcal mass and irritation forms of the intestinal loops.

†Altered structure, retained concretions, and postinflammatory fixation without palpable tenderness.

‡Structural alterations with palpable tenderness localized to the appendix and following its displacement.

§Tenderness localized to the appendix area with marked secondary findings without definite intrinsic change when visualized.

¶Visualized without significant structural alterations, tenderness, or secondary signs.

highest value. They are observed in the vertical abdominal film made at the completion of gastric emptying or at the arbitrary six-hour observation. There are few other frequent causes for these atypical irritation forms than appendicitis and these other conditions have been found to occur mostly in the female pelvis.

This pattern is reliable, when present, as a record of previous acute or subacute appendicitis, although this may not appear in the clinical history. Even in the female, these irritation forms may be so localized to the appendiceal area as unlikely to be the result of pelvic disease. Handling of the intestines at laparotomy will result in this roentgenological picture subsequently, although usually in its lesser degrees of distinctiveness.

The incompetent ileocæcal sphincter has not been given any relation to the disease of the appendix. However, when the cæcum shows good muscular tonus with active haustrations, and with the marked haustral incisura opposing the valve, any accompanying incompetence is due to pathological interference and not to relaxation. Schultze shows that the valve acts mechanically and not as a muscular sphincter and that closure requires tension of the tentorium cæcale in applying the upper lip to the lower. He finds in one-third of cadavers a pathological cause for insufficiency. The pathological causes, other than senile atrophy, may be peri-appendiceal disease or pathological processes of the valve itself. Incompetency of the valve in the presence of good cæcal tonus is evidence of regional disease, which usually is appendicitis, postoperative conditions, or typhlitis. Incompetency of the ileocæcal valve when the cæcum shows good tonus is a supplementary sign of appendiceal disease.

Appendiceal abscess may become localized and clinically subacute. There will then often be characteristic alteration of the barium passage through the adjacent small intestine. The roentgenograms will be helpful in diagnosis. The course of the terminal ilium and the contour of the lower and left border of the cæcum may describe the globular shape of the abscess, which displaces these and other intestinal loops. The irritation forms of the small intestines which are described above will give evidence of the associated regional peritonitis. A palpable mass, fluoroscopically oriented to the appendiceal area and determined to be displacing the terminal ilium and deforming the cæcum, completes the roentgenological evidence.

The operative confirmation of these roentgenological findings of the appendix in 358 instances has justified their use in diagnosis. Only roentgenology will develop the intrinsic and direct signs of appendiceal pathological change. Roentgenograms will in a large percentage of instances show the appendiceal lumen. Often this will indicate definite anatomical changes. Chiefly with, but also without visualization, there may be adduced from the films and by fluoroscopic palpation associated evidence, which will have additional significance. Such objective evidence of anatomical change is not alone proof of an active relation to any clinical syndrome. It must find definite correlation to the clinical findings. The roentgenological facts about the appendix are objective and valid facts which cannot rightly be ignored in diagnostic attention to the appendix. Their consideration in connection with other findings in alimentary and abdominal syndromes will increase the accuracy of diagnosis and can bring about improvement in the adverse statistical results of surgery of the appendix.

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THE TREATMENT OF POSTOPERATIVE TETANY WITH SPECIAL REFERENCE TO THE ADMINISTRATION OF IRRADIATED ERGOSTEROL[1]

LAWRENCE JACQUES, M.D., CHICAGO
Associate in Surgery, Northwestern University Medical School

THE realization that continued toxicity following thyroidectomy for thyrotoxicosis must have its source in residual abnormally functioning thyroid tissue has resulted in a trend toward more radical resection. With adequate excision, the incidence of failure to afford complete and lasting relief has fallen to a very low figure, but unfortunately there has been some increase in the frequency of parathyroid injury. Transient objective evidences of parathyroid damage may be detected in a rather large proportion of cases in which a maximal operation has been performed. These are usually of little importance, being associated with no subjective symptoms whatever, or with mild discomforts readily controlled and disappearing within a few weeks or months after operation. On the other hand, the more severe and lasting cases of manifest tetany constitute perhaps the most unfortunate sequelæ of thyroid surgery. These patients may be reduced to years of partial invalidism, disturbed by frequent spasms and paræsthesias, exhausted by prolonged adherence to a disagreeable regimen, and menaced by the danger of generalized convulsive seizures and cataract formation, with no certainty of eventual spontaneous improvement.

Recent years have pointed the way to methods which may be useful in the prevention of serious parathyroid deficiency. Millzner has called attention to the frequent occurrence of parathyroid bodies on the lateral and even the anterior thyroid capsule and has suggested modifications in technique designed to preserve these structures. Lahey has introduced the method of identifying parathyroid tissue in the removed specimen at operation and of transplanting such bits into the sternomastoid, and Cattel has recently presented experimental proof for the adequacy of such autotransplants. Discouraged by the difficulty in accurately recognizing parathyroids in such specimens, we have made little use of this method.

The active management of the more severe and persistent cases of tetany may present a most difficult problem in therapeutics. The basis for the active treatment of parathyroid tetany is the fundamentally important fact that extirpation of the parathyroid glands is followed by a drop in blood calcium, and that in general measures which tend to restore a normal calcium level simultaneously bring about evidences of clinical improvement. Of the measures available to restore the normal level of blood calcium, the one of greatest practical importance is the oral administration of calcium salts. The efficacy of this method, first suggested by Frouin for the control of experimental tetany, has had adequate demonstration in the work of Luckhardt and Goldberg, and Hjort has provided chemical support for the physiological observations made by these authors. The capacity of various orally administered salts to elevate the blood calcium is now established on a firm experimental basis (Jansen, Hjort, Roe and Kahn). Past failures to demonstrate such an elevation must be attributed to inadequate dosage, or to the determination of blood calcium in specimens drawn after time has been allowed for a return to the pre-ingestion level (Hjort). Of the salts available for this purpose, calcium lactate, because of its adequate solubility, ease of administration, and the readiness with which it is absorbed, has found the most extensive practical use. The problem of establishing the optimum dosage for the oral administration of calcium lactate is as yet unsolved. Roe and Kahn have demonstrated that the maximum degree of calcium absorption occurs from amounts not exceeding 5 grams. It is important, however, that these observations were made on normal human subjects. We have repeatedly observed instances of severe tetany, particularly

[1] From the Surgical Clinic of Dr. H. M. Richter and the Department of Surgery, Northwestern University Medical School.

during periods of acute exacerbation in which massive doses measured in ounces, not grams, have apparently been necessary to control symptoms. On more than one occasion during such crises we have had to administer calcium lactate in amounts approaching the minimum of 1.5 grams per kilogram, found by Luckhardt and Goldberg, to be required for the control of tetany in completely parathyroidectomized dogs. Frouin also used large quantities of calcium (5 to 10 grams of calcium chloride in 24 hours) and the necessity of employing such doses has been emphasized by Hjort and by Dragstedt and Sudan.

Even massive doses of calcium lactate can be taken with relative ease. We have found it convenient where large quantities must be taken for some time to instruct patients to dissolve the entire day's ration at once by heating in water, flavoring the solution with fruit juices, and taking divided doses of the mixture during the day. We have heeded the suggestions of Roe and Kahn that the salts be always given in solution and at a time when the stomach is relatively free of food. Such a regimen is fairly simple and the problem would seem to be solved in a satisfactory way were it not for the fact that the administration of large doses of calcium lactate by mouth for any considerable period is found almost invariably to be followed by nausea, abdominal pain, and diarrhœa. With the appearance of these symptoms, we have been accustomed to resort to injections of parathormone or to switch to some less irritating calcium salt. Under these conditions we have frequently prescribed calcium carbonate. The grittiness of this insoluble powder, when taken in large doses in suspension, is disagreeable to the average patient. We have had at least one patient in whom the continued ingestion of calcium carbonate was followed by symptoms of gastro-intestinal irritation. Furthermore, this substance must depend upon the acids of the gastric juice for solution, and hence it may be ineffective in subjects with lowered or absent gastric acidity. We have occasionally given the carbonate in combination with calcium lactate to check the diarrhœa produced by the latter, and used in this way it has been of distinct value. The irritating properties of calcium chloride prohibit its use in adequate doses. We have as yet had little experience with calcium gluconate. In 3 cases we have seen a severe diarrhœa follow its use in large amounts and Szurek has observed similar symptoms following the administration of large doses of calcium gluconate to dogs. The diarrhœa from calcium gluconate may also be conveniently checked by moderate amounts of calcium carbonate. Intravenous calcium injections are of use only in the treatment of acute symptoms, and here, because of its safety, calcium gluconate has superseded the other calcium salts. In 2 patients we have employed intramuscular injections of calcium gluconate. One patient has been giving herself such injections whenever active symptoms have threatened.

To supplement the oral administration of calcium, lactose has been given by mouth. This measure has its origin in the observations of Dragstedt and his collaborators that tetany can be prevented in parathyroidectomized dogs by diets of milk, bread, and lactose. Evidence has been presented by Irving and Ferguson to the effect that the degree of calcium absorption from the intestine is a direct function of the acidity of the medium in which it is introduced. Thus, the efficacy of lactose may be attributed to the aciduric flora produced and the consequent facilitation of calcium absorption. Evidence that lactose given by mouth increases the absorption of calcium has been presented by Bergheim, and Greenwald has recently shown that lactose protects against tetany only if large amounts of calcium are contained in the diet. It would seem, therefore, that increasing the dosage of calcium would constitute a more direct measure than the addition of lactose to the diet. The dietary outlined by Dragstedt, with its resulting severe diarrhœa, is obviously not available as a practical clinical measure.

Substitution therapy for parathyroid deficiency is still on a most unsatisfactory basis. Parathormone is of great value for the relief of acute symptoms, and may be invaluable to tide severe cases over periods during which adequate doses of calcium by mouth cannot be tolerated. Its expense, and the inconvenience of a method of sustaining life by frequent

hypodermic injections are serious practical objections to its use over long periods of time. Furthermore, the observation has recently been made by Albright, Bauer, Ropes, and Aub, that patients may develop an immunity to this agent, so that it becomes ineffective with repeated administration. We have ourselves observed 1, and possibly 2 cases in which such immunity seemed to be acquired. A case in which parathormone was entirely without benefit unless given together with thyroid extract, orally administered, has been reported by Hjort and Eder. Homotransplantation of parathyroids has yielded few gratifying results. The difficulty in obtaining material, the frequency of complete failure to afford relief, the transiency of improvement in those isolated instances in which it has been alleged to occur, are all factors which have discouraged extensive recourse to this measure. One of our patients received a single transplant without clearly demonstrable improvement. Unfortunately, no preparation of parathyroid, which is consistently effective when given by mouth, is available. Obviously, such a preparation would constitute a final and ideal solution of the problem.

We have had no extensive experience with the various other measures which have been suggested for the control of parathyroid tetany. Kaolin has not been used except to control the diarrhœa following calcium lactate or lactose administration. We have not employed ammonium chloride. Favorable results have been obtained with it in experimental tetany by Boyd, Austin and Ducey, and Wenner, and Freudenberg and György report its successful use in one case of human postoperative tetany.

It becomes evident from this discussion that there is a serious need for some simple adequate method for the control of tetany, particularly for those cases in which management must be continued over a considerable period of time.

During recent years, it has been demonstrated that infantile rickets and tetany can be controlled clinically and chemically by the administration of cod liver oil. It was subsequently shown that exposure of such patients to sunlight or to ultraviolet irradiation was followed by similar improvement. In the series of investigations which followed, figuring most prominently the names of Steenbock, Hess, Windaus, Rosenheim and Webster, these facts were strikingly correlated. It was found that various foodstuffs could be rendered antirachitic by irradiation; that the activation so conferred was localized in the lipoidal constituents, such as the sterols and closely related compounds, and finally that the specific agent so activated could be separated from cholesterol itself. This substance was finally identified as ergosterol—a sterol widely distributed in plant life. Ergosterol, activated by irradiation, is at present regarded as the antirachitic vitamin, or vitamin D, and has received the name of viosterol. To its presence is attributed the activity of cod liver oil, and the effectiveness of ultraviolet light has been accounted for by the production and absorption of vitamin D from the skin following irradiation.

The efficacy of irradiated-ergosterol in infantile tetany has been firmly established by clinical investigation (Hess and Lewis, György, Prinke, Bakwin, Bakwin and Gottschall, and others). The administration of adequate doses results practically without exception in complete clinical improvement, with a restoration of normal blood chemistry. Furthermore, Hottinger has reported the successful use of irradiated ergosterol in several cases of spontaneous tetany in adults. The success of this treatment in spasmophilia and spontaneous adult tetany, conditions so closely related clinically and chemically to parathyroprival tetany, led us to consider its use in the more prolonged and severe cases of postoperative tetany in human beings. Two practical advantages for this method presented themselves. In the first place, the administration of adequate doses of irradiated ergosterol incorporated in foodstuffs or dissolved in oil, is simple and not disagreeable. Second, the observation of Hess and Lewis that the elevation of blood calcium following its administration may be present for longer than 30 days after the discontinuation of the drug, led us to hope that complete control of tetany might be obtained by intermittent administration, with periods of complete freedom from

the annoyance of any type of management. We were not frightened by reports of the toxicity of this agent (Kroetz, Pfannenstiel, Kreitmar and Moll, Harris and Moore, Smith and Elvove, Klein, and others). The production of injurious effects in animals by a deliberate huge overdosage is of no practical therapeutic importance. We are in agreement with Hess, Lewis and Rivkin that "too much has been made of these studies."

The literature on the use of vitamin D in its various forms in parathyroprival tetany, yields much conflicting, and on the whole, discouraging evidence. Reports on the effect of vitamin D on experimental parathyroid tetany in animals have been made by several investigators. Swingle and Rheingold found that exposure of parathyroidectomized dogs to ultraviolet light greatly prolonged the life of such animals and brought about a striking amelioration of the violent symptoms. The animals, nevertheless, finally succumbed from tetany or exhaustion. Similarly, Pincus, Peterson and Kramer were able somewhat to prolong the lives of parathyroidectomized dogs by ultraviolet irradiation. During the following year it was reported by Jones that the daily administration of 20 cubic centimeters cod liver oil for 2 weeks before operation prevented tetany and greatly increased the life of parathyroidectomized dogs. The administration of similar doses only after operation was without effect. Gates and Grant were able to prevent tetany following the removal of the external parathyroids in rabbits by repeated exposure to ultraviolet rays previous to operation, and Jung found that a favorable effect was exerted by ultraviolet radiation in rats when exposures were made beginning several days previously or from the day of operation. Brougher reported that cod liver oil delayed the onset and ameliorated the symptoms of tetany in parathyroidectomized dogs. Subsequently irradiated ergosterol in the form of acterol was found to exert a favorable effect on the course of tetany in dogs when administration was begun on the day of operation. Attempts to control active tetany by intramuscular and intravenous injections of acterol were unsuccessful unless made in conjunction with administration of large amounts of milk by stomach tube. Wade has recently reported results similar to Brougher's, cod liver oil being used before operation. In contrast to these somewhat encouraging reports, Urechia and Popoviciu were unable to note any appreciable benefit from irradiated ergosterol on parathyroprival tetany in dogs, and Greenwald was entirely unable to confirm the favorable results obtained by Jones with cod liver oil. This author also unsuccessfully attempted to control active tetany in dogs by the administration of massive doses of irradiated ergosterol. Hess and Sherman failed entirely to affect favorably the course of experimental tetany in dogs with large doses of irradiated cholesterol, and in a single experiment by Hess, irradiated ergosterol afforded no protection when administered to a parathyroidectomized monkey, although tetany produced by a low calcium diet previous to parathyroidectomy in the same animal, had been effectively controlled by this agent. Later Hess, Weinstock, and Rivkin reported further experiments in monkeys and dogs, in which the blood calcium could not be elevated markedly by irradiated ergosterol, following parathyroid extirpation. More recently, however, the same authors have succeeded in elevating the blood calcium in parathyroidectomized animals using from 100 to 800 times the therapeutic dose.

The literature reveals few instances of the employment of vitamin D in the treatment of postoperative tetany in human beings. Jackson, in 1927, reported apparently distinct benefit from ultraviolet irradiation in a case of postoperative tetany of 2 years' standing. Brougher recorded 3 cases of human postoperative tetany which were treated with apparent success by the administration of cod liver oil, and has recently reported the successful treatment of these 3 cases and a fourth with small doses of viosterol. The remarkably prompt return of symptoms following the withdrawal of the drug (in 1 case even a day's omission led to a recurrence of symptoms) leads one to question the rôle of viosterol in the improvement observed. A more convincing, though not entirely conclusive, case of human postoperative tetany successfully treated with irradiated ergosterol is that of

Stern. His patient presented a severe postoperative tetany of 15 years' standing which had had its onset 2 weeks after a goiter operation. The manifestations were severe, with repeated attacks of generalized convulsions and trophic disturbances of the hair and nails. Cod liver oil, parathyroid preparations, ultraviolet irradiation, and a parathyroid transplant had been without material or lasting effect. Irradiated ergosterol in the form of vigantol was administered in doses of 3 to 4 milligrams three times daily, with the surprising result that in 2 weeks there was marked clinical improvement which amounted at the end of 6 weeks to practically a complete symptomatic and objective cure. Deming, on the other hand, has had completely negative results with irradiated ergosterol in several cases of human postoperative thyroid tetany, and Elmer and Scheps have reported one case of human postoperative tetany, which was entirely refractive to vigantol.

We wish briefly to present a series of observations on the administration of irradiated ergosterol (in the form of acterol) to 6 patients with postoperative tetany. These patients, all of them women, ranged in age from 24 to 31 years. Thyroidectomy had been performed in each case for thyrotoxicosis from 2 months to 5 years previous to the period of observation. In one case operated upon elsewhere, the diagnosis of hyperthyroidism had not been clearly established, and we have no exact record of the operative procedure. In the 5 remaining patients, a maximal excision had been performed. Tetany in each case appeared within a few days following operation. Four of these patients presented mild active tetanic manifestations and the remaining 2 are to be classified as cases of severe tetany. Every case had been shown previous to or during the period of these observations to be amenable to calcium therapy. Patient A. P. presented the most severe and persistent symptoms, and had been a trying problem to us for a period of years. It was upon this patient that a parathyroid transplant had previously been performed with questionable benefit. Five of the 6 cases observed were made accessible to me through the kindness of Dr. H. M. Richter, at whose instigation this study was undertaken.

METHODS

The practical difficulties in evaluating any method of therapy in a condition as labile as parathyroprival tetany will be readily appreciated by those who have had an opportunity to observe such cases. The frequent and constantly altering discrepancies between objective, subjective, and chemical manifestations; the constant fluctuations in severity with menstruation, pregnancy, infections, deliberate or accidental breaches in diet, and frequently without respect to any recognizable external factors, necessitate the most conservative and painstaking observation before justifiable conclusions can be drawn.

Examinations were made as nearly as possible once weekly. The criteria chosen for study were the subjective manifestations of stiffness, spasms, and paræsthesias; the objective evidences of increased neuromuscular irritability—which were here restricted to Chvostek's and Trousseau's signs; and estimations of the inorganic phosphate and calcium of the blood. The determination of the electrical excitability of the peripheral nerves (Erb's sign) was omitted because of the disagreeableness of the procedure to most patients. Nevertheless Erb's sign, when elicited under proper conditions, is perhaps the most reliable and consistent clinical index of the degree of parathyroid deficiency. An attempt was made to follow Chvostek's and Trousseau's signs in a roughly quantitative way, so that comparisons in intensity could be made. In eliciting Chvostek's sign, the division into degrees as suggested by v. Frankl Hochwart, was in part adopted. Contraction of the eyelid, nose, and corner of mouth elicited upon tapping over the facial nerve just anterior to the external ear, was recorded as Chvostek I; of the nose and mouth or of the mouth alone upon tapping beneath the zygoma, Chvostek II. Chvostek I is regarded as more significant than II and may not be present in milder cases. The intensity of response was further recorded as 1 to 4 plus. The fact that Chvostek's sign has been found positive in conditions other than tetany does not reduce the value of this finding as a criterion of the severity of tetany in cases in which it has appeared definitely after operation, together with other

indisputable tetanic manifestations (Chvostek, Pavel, Claudion and Carnateanu).

Trousseau's sign was always elicited by means of a blood pressure cuff pumped up to approximately the same pressure at each observation. The intensity of the spasm which developed and the time required for its development were recorded. This sign—elicited in such a manner—is a fairly sensitive clinical index and on the whole seems more significant and reliable than Chvostek's sign.

An attempt was made to obtain blood for calcium and phosphate determinations weekly and specimens were drawn as closely as possible to the time of clinical observation. In these cases in which calcium was being taken along with the acterol, blood was always drawn at least 15 hours and usually a longer period after the last ingestion of calcium—a period theoretically long enough to permit a return to the pre-ingestion level.

Irradiated ergosterol was administered in the form of acterol.[1] At the outset small doses were used, but these were rapidly increased, so that in some cases the equivalent of as much as 10 milligrams daily, was given. For the administration of the larger doses, preparations of three to ten times the strength agreed upon by the council on pharmacy and chemistry for the marketing of viosterol, were made available to us. We have observed no toxic effects from the amounts used.

RESULTS

The details of these experiments are presented in the records. In the cases of severe tetany studied (Cases 1 and 2), the administration of acterol was followed by no material subjective or objective improvement. In the first of these cases, the experiment was continued over a period of 14 weeks, the dose being gradually increased, until approximately 10 milligrams (3 cubic centimeters of a 1000 D preparation) were being taken daily. The results are complicated somewhat by the patients' insistence upon an irregular and haphazard calcium intake. Still at no time, except perhaps during the week beginning on June 25, 1929, was there even apparent clinical improvement. In the second, in which operation had been performed only 2 months previous to these observations, 3 cubic centimeters of a 1000 D preparation were given for a period of one month. While the patient had been able to reduce her calcium ration somewhat during this period, she was still suffering from active manifestations of tetany at the time when irradiated ergosterol was discontinued, in spite of repeated parathormone injections, large doses of calcium, and a carefully restricted diet.

In the 4 remaining and milder cases, results were considerably more variable—in all probability because of spontaneous fluctuations in severity. The interpretation of these experiments, therefore, presents serious difficulties. Thus, in Case 3, the patient insisted that she started to improve almost immediately upon being put on small doses of acterol. Spasms and tingling occurred less frequently and were much milder than before and objectively there were slight evidences of improvement. Symptoms became more severe almost immediately upon the discontinuation of the drug, but such an exacerbation can hardly be attributed to this factor in view of the sustained action of irradiated ergosterol following withdrawal, as observed by Hess and Lewis. Furthermore, when after a week of rest, the same patient was given considerably larger doses (45 minims of a 1000 D preparation) over a period of 4 weeks, there was no material clinical evidence of improvement. Thus, we are forced to regard the result as a negative one. It is of interest that this patient presented a strongly positive Chvostek before operation, which had been unaccompanied by other evidences of tetany.

In our second mild case (Case 4) symptoms were confined largely to menstrual periods. During the period having its onset several days after the beginning of acterol administration, objective and subjective evidences of tetany were pronounced. Following the menstrual period there was rapid improvement and during the next menses there were no active tetanic symptoms. Nevertheless, several days later, when the patient stated with emphasis that she was "decidedly better," Chvostek's sign was briskly positive, and

[1] Supplied through the courtesy of Mead, Johnson & Company.

a carpal spasm developed practically immediately upon applying constriction to the arm. After 66 days acterol was withdrawn and during the following 5 weeks there was no material clinical change. At the end of this period, symptoms again became more marked, and a second course was again followed by apparent improvement. After 3 weeks of rest, this patient was placed on a third course of acterol, this time in considerably larger doses, in the hope of obtaining a more clearly defined result, and for the third time definite improvement appeared to ensue. Thus, on July 17, 1929, when the final course of treatment was started, the patient was menstruating, and objective and subjective evidences of tetany were present. On October 15, 1929, when the drug was stopped, the patient was again menstruating, but she was symptom-free, and the objective signs were distinctly less pronounced.

The 2 remaining cases offer similar difficulties in interpretation. In Case 5, distinct improvement followed upon the administration of calcium, and persisted when acterol was given and the calcium intake rapidly reduced. After 4 weeks of acterol, however, Chvostek's and Trousseau's signs were still positive, although there were no subjective symptoms of tetany. About 17 days after the withdrawal of acterol, there was a return of mild symptoms. At this time, a second course of acterol alone was again followed by both subjective and objective improvement. Nevertheless, after 3½ weeks of acterol alone, Chvostek's and Trousseau's signs were still positive. Acterol was now discontinued for the second time, and during the following 6 weeks, there were no tetanic symptoms. At the end of this period, there was a recurrence of very mild disturbances.

In the last case, as in the preceding one, acterol and calcium were given simultaneously. The improvement which promptly followed, again appeared to persist in spite of a rapid reduction in calcium intake. Nevertheless on July 28, 1929, after 10 cubic centimeters of acterol had faithfully been taken daily for a period of 52 days, the beginning of a menstrual period was attended by tingling and mild carpal spasms; and 2 days later, in spite of small doses of calcium, Chvostek's and Trousseau's signs were mildly but distinctly positive. The complete withdrawal of calcium 2 weeks later was followed by a week's freedom from trouble, but moderate symptoms then returned, and on August 20, 1929, after 74 days of acterol, Chvostek's and Trousseau's signs were again positive. The withdrawal of acterol at this time was followed in a few days by a gradually intensifying train of symptoms, culminating in a severe attack of tetany 2 weeks later. The relationship of this return of symptoms within so short a period after the withdrawal of acterol must again be regarded as questionable.

To summarize, in the 2 severe cases of tetany observed, the administration of irradiated ergosterol in large doses was without appreciable benefit. In 3 of the remaining 4 milder cases, some degree of improvement appeared to follow the administration of this agent. In 1 of these (Case 4) such improvement ensued with three successive courses of treatment.

Blood calcium and phosphate determinations were made as frequently as possible during the course of these observations. Because of certain inconsistencies in the figures we wish to defer their publication until further data have been obtained.

DISCUSSION

While the interpretation of the apparent benefit resulting from irradiated ergosterol in 3 of our 4 mild cases is exceedingly difficult, the rôle of irradiated ergosterol in this improvement cannot be entirely excluded. On the other hand, it is to be pointed out that in no case did this agent afford the complete and striking relief following its use in infantile tetany or following adequate calcium administration in parathyroid tetany. This failure may throw some light on the mechanism by which vitamin D exerts its effect. Two theories are available to explain the relief afforded by vitamin D, variously administered, in infantile tetany and rickets. One is based on the repeated observation that this agent decreases the hydrogen-ion concentration of the intestinal content, and thereby facilitates calcium absorption (Zucher and Matzuer, Abrahamson

and Miller, Yoder, Grayzel and Miller, Jephcott and Bacharach, Bauer and Marble). The other theory has its source in the reports of Grant and Gates that ultraviolet light produces a true parathyroid hyperplasia with an increase in potential functional capacity. In harmony with these observations are the reports of Nonidez and Goodale, and Higgins and Sheard. Were direct stimulation of the parathyroids the basis for the activity of vitamin D, some benefit should have followed in all of our patients, since it may be assumed that in no case, even the most severe, had a complete parathyroidectomy been performed. We are more inclined to feel that the essential failure of irradiated ergosterol in these experiments, indicates that this agent produces its effect entirely independently of the parathyroids; and that the changes brought about by its administration are fundamentally different from those needed to combat the group of conditions resulting from parathyroid extirpation. Thus, the analogy between parathyroid tetany and infantile and spontaneous adult tetany, which is so complete with respect to clinical and chemical manifestations, must stop when these similarities have been pointed out. The failure of vitamin D therapy may be regarded with György as an important therapeutic test establishing a profound and fundamental difference in the pathogenesis of these conditions.

SUMMARY

Six cases of human postoperative tetany treated with irradiated ergosterol (acterol) are reported. In the 2 more severe cases of the series, no improvement resulted from the use of this agent. In 3 of the 4 remaining cases, variable degrees of improvement, in which the rôle of irradiated ergosterol could not entirely be excluded, appeared to ensue. It is felt that these observations do not sustain the view that the action of vitamin D occurs through the agency of the parathyroid bodies.

CASE I

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
4-22-29	4+	4+	I & II 4+	4+ 50 sec.	Calcium lactate 15 gms. daily. (Blood Ca.—6.2). Acterol —50 m. daily.
4-25-29	4+	4+			Menses. Taking large amounts of calcium lactate-several ounces daily.
4-30-29	4+	4+	4+	4+	Acterol increased to 60 m. daily. No calcium since 4-28 a.m.
5-10-29	2+	0			Calcium lactate 60 gm. daily on the average. Acterol continued 60 m. daily.
5-21-29	4+	2+			Acterol increased to 10 c.cm. daily.
6-4-29	4+	4+	I & II 4+	4+ 45 sec.	Calcium lactate about 30 gm. daily—much more necessary during last menses. Acterol continued 10 c.cm. daily.
6-11-29	4+	2+	I & II 4+	4+ 10 sec.	No calcium for 2 days. Acterol 10 c.cm. daily.
6-19-29	4+	4+	I & II 2+	2+ 50 sec.	Calcium about 30 gm. daily. Acterol 10 c.cm. daily continued.
6-25-29	1+	0		1+ 2 min.	On 15 gm. of calcium carbonate daily. On acterol 10 c.cm. daily—5 weeks
7-2-29	2+	0	3+	1+ 90 sec.	Calcium carbonate 30 gm. daily. Acterol continued as above.
7-9-29	4+	3+	I & II 4+	3+ 1 min.	Troubles returned on 7-3-29. Took calcium lactate, 6 oz. daily for several days. Acterol 10 c.cm. daily continued.
7-16-29	4+	4+	I & II 2+	1+ 1 min.	Superacterol (1000D) 45 m. daily started on 7-12-29. Calcium lactate 30 gm. daily.
7-29-29	4+	4+			Having much trouble in spite of 8 tablespoonfuls of calcium lactate and 45 m. of superacterol daily.
8-6-29	2+	2+	I & II 4+		Has had superacterol 45 m. daily for 21 days. Severe carpal spasm present during examination.

Case 1. A. P., aged 24 years, had a maximal thyroidectomy performed on September 22, 1924. Chvostek's and Trousseau's signs were positive on the following day, and soon after the patient developed severe carpal spasms, numbness and tingling of fingers, and stiffening and twitching of the facial muscles. These symptoms recurred and were kept under control as well as possible by orally administered calcium, parathormone injections, and lactose, with frequent alterations in regimen to meet new indications and parallel fluctuations in severity. On October 24, 1927, a parathyroid transplant was performed, material being obtained from a still-

CASE II

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
8-7-29	1+	0	I & II 0	1+ 90 sec.	Calcium lactate 60 gm. daily. Parathormone 1 c.cm. daily. Superacterol (1000D) 45 m. daily started.
8-14-29	0	0	0	1+ 2 min.	Parathormone 1 c.cm. daily. Calcium lactate reduced to 30 gm. daily. Has had some twitching of facial muscles. Superacterol continued.
9-2-29	4+	4+			Reported much twitching of hands; necessitating additional parathormone injections. Calcium lactate and superacterol continued as above.
9-6-29	4+	4+			Reported marked twitching and frequent severe carpal spasms in spite of calcium lactate 45 gm. daily, parathormone 1 c.cm. and superacterol 45 m. daily. Acterol has been taken for 1 month. Stopped.

Note.—This patient later appeared to become refractive to parathormone and presented a most difficult problem in management. She is at present entirely controlled on 50 gm. of calcium gluconate daily, supplementing with occasional intramuscular injections and controlling any tendency to diarrhœa with calcium carbonate.

CASE III

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
4-25-29	3+	3+	I & II 4+	4+ (violent) 1 min.	Acterol 30 m. daily—started. Taking no calcium. Blood cal.—6.8.
5-13-29	3+	2+	I & II 4+	4+ at once	Spasms less severe; not less frequent. Acterol increased to 50 m. daily.
5-28-29	2+	2+			Symptomatically improved; not examined on this day. Acterol 50 m. continued
6-5-29	1+	0	I & II 1+	1+ 45 sec.	Occasional stiffness in fingers. Acterol 10 c.cm. daily continued.
6-11-29	1+	0			Unable to report for observation.
7-9-29	1+	0	I & II 3+	1+ 75 sec.	Acterol 10 c.cm. daily continued. Had slight tingling during menses 3 weeks ago.
8-16-29	2+	2+	I & II 4+	4+ 25 sec.	Acterol 10 c.cm. daily stopped on 8-9-29 after 74 days. Menstruating today. Moderate tingling and spasms since last visit. Superacterol (1000D) 40 m. daily started.
8-27-29	0	3+	I & II 4+	2+ 30 sec.	Superacterol continued as above.
9-17-29	2+	4+ frequent and severe	I & II 4+	4+ 20 sec.	Superacterol—40 m. daily taken until yesterday—total of 40 days.

birth. After 2 or 3 weeks of apparent marked improvement, symptoms returned with about their former intensity. On April 2, 1928, a diagnosis of pregnancy was made, and the patient remained entirely free of tetanic symptoms throughout pregnancy, being delivered of a normal infant at full term. This remarkable improvement persisted until March, 1929, when all of the previous manifestations of parathyroid deficiency returned.

CASE 2. G. O., aged 25 years. In 1921 a thyroidectomy was performed elsewhere for hyperthyroidism. Operation was followed by distinct improvement, but relief was not complete. After about 4 years, symptoms began to increase in severity. In March, 1924, there was an acute attack of tetany, relieved by a "hypodermic" and calcium chloride. The administration of calcium chloride was continued for several months. There were no further manifestations of tetany, except for occasional slight fibrillary twitchings of the small muscles of the hands. The basal metabolic rate on May 20, 1929, was 60 plus. On June 4, 1929, a second operation was performed. No thyroid tissue could be found on the right side, but a large mass, friable and obviously hyperplastic, was removed on the left—with care to avoid injury to the posterior capsule. The postoperative course was uneventful until the seventh postoperative day, when there was a severe attack of tetany, relieved by an injection of parathormone. Similar attacks occurred subsequently at frequent intervals, and could be prevented only by massive doses of calcium and daily parathormone injections. Blood calcium on June 27, 1929, was 6.7.

CASE 3. P. K., aged 30. When first seen by us on January 13, 1927, Chvostek's sign was strongly positive, but Trousseau's sign was negative after 2½ minutes of constriction. There had never been any numbness, tingling, or stiffening. On February 5, 1927, a maximal thyroidectomy was performed. On the following day, stiffness and fibrillary twitching of the facial musculature were present and Trousseau's sign had become strongly positive. These symptoms recurred and were relieved by parathormone injections and moderate doses of calcium. Patient was discharged on a ration of 12 teaspoonfuls of calcium lactate daily. She was lost sight of for about 2 years and returned on March 21, 1929. At this time she stated that numbness, tingling, and spasms were continuing to occur at frequent intervals, particularly just before menses. No calcium was being taken, and no dietary restrictions were observed.

CASE 4. L. S., aged 31 years. Maximal thyroidectomy performed on May 12, 1928. Chvostek's sign

CASE IV

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
4–25–29	None recently	None recently	I & II 2+		Acterol 30 m. daily started. No calcium being taken. Blood Ca.—7.8.
4–30–29	4+	4+	I & II 4+	4+ 10 sec. (Slight spasm before application of cuff)	Menses began on this day. Symptoms more marked than in last few periods. Calcium carbonate—8 drams daily. Acterol increased to 50 m. daily.
5–3–29	Reported as "much better." Calcium stopped.				
5–14–29	1+	None since one 5–6	I & II 1+	1+ 30 sec.	Acterol 60 m. daily. No calcium.
5–23–29	0	0	I & II 1+	1+ 45 sec.	Acterol 10 c.cm. daily started.
6–5–29	1+	0	I & II 3+	2+ almost at once	"Decidedly better"—No symptoms whatever during menstrual period from 5–25 to 5–30. Not free from symptoms during any previous period since operation. Acterol 10 c.cm. daily continued.
6–11–29	1+	0	R 1+ L 2+	1+ 30 sec.	Acterol 10 c.cm. continued
7–1–29					No symptoms since 6-11. Acterol stopped.
7–29–29	0	0	R 1+ L 2+		Last menses 7–21 to 7–26. Slight tingling, no spasms.
8–6–29	3+	Some stiffness of feet	I & II 2+	1+ 40–60 sec.	Troubles returned abruptly. Acterol 10 c.cm. again started.
8–13–29	1+	0	I & II 1+	1+ 45 sec.	Acterol 10 c.cm. continued.
8–20–29	0	0	I & II 2+	1+ 20–30 sec.	Acterol 10 c.cm. continued.
8–27–29	1+	0			Acterol stopped
9–10–29	1+	0	I & II 3+	1+ 60 sec.	No medication for 13 days.
9–17–29	1+	Stiffness. No definite spasms	I & II 4+	2+ 20 sec.	No medication whatever for 20 days. Patient is menstruating. Superacterol (300D) 8 c.cm. daily started.
9–24–29	1+	0	I & II 2+	2+ 30 sec.	Superacterol continued as above.
10–1–29	1+	0	I & II 1+	1+ 60 sec.	Superacterol continued.
10–8–29	0	0	I & II 1+	1+ 90 sec.	Superacterol continued.
10–15–29	0	0	1+	2+ 45 sec.	Menstruating Superacterol. Stopped after 28 days.

CASE V

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
6–27–29	2+	2+	2+	2+	Calcium lactate 8 drams daily, started.
7–2–29	1+	0	I & II 1+	1+ 60–80 sec.	Calcium lactate 8 drams daily continued. Blood Ca.—7.7.
7–10–29					Acterol 10 c.cm. daily, started. Calcium lactate 6–8 drams daily.
7–17–29	1+	0	I 1+ II 2+	1+ 30 sec.	No calcium last night and this morning. Calcium lactate reduced to 2 drams daily. Superacterol (1000D) 45 m. daily.
7–25–29	1+	0	I 0 II 2+	1+ 2 min.	No calcium for 36 hours. Calcium lactate 1 dram daily. Superacterol 45 m. daily continued.
8–1–29	1+	0	I 0 II 2+	1+ 90 sec.	No calcium for 36 hours. Calcium stopped, superacterol continued.
8–7–29	0	0	I & II 1+	1+ 30 sec.	No calcium for 8 days. Acterol stopped—Has had acterol 7 days, superacterol 21 days.
8–14–29	0	0	0	1+ 2 min.	No medication for 1 week. States that she has previously been symptom-free for 1 or 2 months without treatment. "Not so well for many months."
8–28–29	1+	Stiffness of hands. Facial twitching	I 1+ II 2+	1+ 50 sec.	No medication for 3 weeks. Mild disturbances returned a few days ago. Superacterol (1000D) 30 m. daily, started.
9–4–29	1+	0	I 0 II 1+	1+ 50 sec.	Superacterol 30 m. daily.
9–11–29	1+	Slight stiffening	I 0 II 1+	1+ 70 sec.	Acterol 10 c.cm. daily "Much better." Very slight feeling of stiffness in hands.
9–17–29	0	0	I 0 II 1+	1+ 80 sec.	Acterol 10 c.cm. continued. Practically no trouble. Slight stiffening when arm rests in certain positions.
9–23–29	0	0	I 0 II 1+	1+ 1 min.	Acterol stopped.
11–13–29	1+	Occasional twitching about mouth and eye	I 0 II 2+	1+ 1 min. & 45 sec.	No medication for 7 weeks. Mild symptoms returned about 1 week ago.

was definitely positive 48 hours after operation and some tingling and stiffness of the fingers appeared on the third day after operation. On moderate doses of calcium lactate no further active symptoms

CASE VI

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
6-6-29	2+	2+	1+	1+ 1 min.	Calcium lactate 8 drams daily and acterol 10 c.cm. daily —started today. Blood Ca.—7.1.
6-12-29	0	0	0	0	Has been taking calcium lactate about 4 oz. daily. Reduced to 8 drams daily. Acterol 10 c.cm. daily continued.
6-19-29	0	0	0	0	Calcium lactate and acterol continued as above.
6-25-29	0	0	0	0	No calcium since 24 hours before examination. Calcium lactate reduced to 4 drm. daily. Acterol—10 c.cm. daily.
7-8-29	0	0			Not examined on this day. Calcium lactate 2 drams daily.
7-16-29	0	0	0	1+ 1 min.	No calcium for 28 hours. Calcium lactate 1 dram daily. Acterol 10 c.cm. daily continued.
7-23-29	0	0	0	0	Calcium stopped. Acterol 10 c.cm. daily —continued.
7-30-29	2+	2+	I 1+ II 0	1+ 45 sec.	Since beginning of menses on 7-28 has had tingling and mild carpal spasms, relieved by small doses of calcium lactate. No calcium during last 28 hours. To take calcium lactate one dram daily for a few days. Has been on acterol 10 c.cm. daily for 54 days. To continue.
8-6-29	0	0	0	1+ 2½ min.	Has continued calcium lactate 1 dram daily until today. Questionable twitching of neck muscles yesterday. To stop calcium again and continue acterol 10 c.cm. daily.
8-13-29	0	0			No calcium for 1 week —free from symptoms. Not examined.
8-20-29	1+	0	1+	1+ 1 min.	Numbness in right arm on 8-15, 16, 17, relieved by small doses of calcium. Various complaints during last few days —weakness, faintness, dizziness, "pain in head." Sodium bromide—45 grains daily. Acterol stopped—(10 c.cm. daily taken for 10 weeks). No calcium.
9-3-29					Numbness and tingling recurred several days after last visit —increasing in severity in spite of small doses of calcium. Today seen in violent carpopedal spasm—relieved promptly by calcium gluconate, 4 drams orally. Calcium lactate 8 drams daily, started.
9-14-29	0	0	0	0	Calcium lactate 6 drams daily.
9-24-29	0	0	0	0	Continues calcium lactate 6 drams daily. No symptoms.
10-29-29	1+				Tingling "all over" since beginning of menses on 10-26. Not examined.
12-5-29					Carpopedal spasm 3 weeks ago. No trouble since. On calcium lactate 6 drams daily.

occurred until June 14, 1928, when the onset of a menstrual period was accompanied by stiffness and numbness of the fingers and definite carpal spasms. Chvostek's and Trousseau's signs at this time were strongly positive. Numbness, tingling, and stiffness continued to occur during menses, in spite of moderate doses of calcium and a meat-free diet. There was relatively little trouble between menstrual periods.

CASE 5. R. G., aged 24 years. A maximal thyroidectomy was performed on April 15, 1927. Patient began to complain of numbness and tingling in hands and feet after leaving hospital, and examination revealed positive Chvostek's and Trousseau's signs. On small doses of calcium, subjective symptoms almost entirely disappeared, although Chvostek's sign remained positive. From March 2, 1928, to November 15, 1928, no calcium was taken, and there were no subjective manifestations of tetany. At about the latter date, numbness and tingling returned, promptly disappearing when treatment was started again, and reappearing when treatment was again discontinued.

CASE 6. B. S., aged 31 years. A thyroidectomy was performed elsewhere 2 years ago. The details of this operation are not available. On the seventh day after operation, patient began to complain of numbness and tingling and stiffness of the facial muscles, and carpopedal spasms occurred. These symptoms have been recurring at intervals of 1 or 2 weeks since, and have been particularly noticeable during menses. She has never been on an adequate and careful regimen.

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OPERATIONS ON SOLITARY KIDNEYS AND URETERS

Report of Fifty-Two Cases[1]

WALTMAN WALTERS, M.D., F.A.C.S., Rochester, Minnesota
Division of Surgery, The Mayo Clinic
AND
WILLIAM WRIGHT, M.D., Rochester, Minnesota
Fellow in Surgery, The Mayo Foundation

A REVIEW of the literature reveals numerous reports of operations on the solitary kidney. For the most part, such operations have consisted of removal of calculi or drainage of the kidney by nephrostomy. In such cases, usually, the opposite kidney had been removed previously for stone; hydronephrosis may have been a complication. Recently, the successful outcome following ureteropyeloneostomy for the relief of anuria with hydronephrosis caused by complete obstruction at the ureteropelvic juncture of a solitary kidney, and the successful outcome of pelviolithotomy in 2 cases in which the kidney was solitary, has led to a review of cases in which operations have been performed on a solitary kidney or ureter at The Mayo Clinic. The purpose of the review has been to determine the causes, the risk, and the results of operations in such cases. The group consists of 52 cases, in 45 of which operations were undertaken for the removal of stone.

In one of the earliest cases to which reference was found in the literature, operation was done by Ferguson in 1902. The patient, a boy of 8 years, had undergone right nephrectomy in November, 1901. The following month, suppression of urine occurred, due to an obstructing stone in the left kidney, for which left nephrolithotomy was performed. Two months later, a stone was removed from the urethra by meatotomy, and a month later cystostomy was done, and a vesical calculus was removed. Ferguson reported that the patient made complete recovery.

By removing segments of solitary kidneys in rabbits, from which the opposite kidneys had been removed previously, Tuffier determined the minimal amount of renal tissue necessary to maintain life, and estimated that in man life could be maintained with from 80 to 100 grams of sound renal tissue. Babcock, in 1907, called attention to the clinical fact that one-half to two-thirds of a single functioning kidney was sufficient to maintain life and that the ability of the kidney to withstand multiple and extensive operations and trauma was due to the power of regeneration and hyperplasia possessed by the organ. Further clinical confirmation of this can be found in a case in which operation was done in 1910 by W. J. and C. H. Mayo and which was reported in 1917. At that time, they stated that they had been impressed with the fact that a person can maintain not only life, but also working power, with what amounts to not more than half of a normal kidney. In support of this, they described the case of a man, aged 44 years, who came with a stone in the remaining kidney 4 years after stones had been removed from the same kidney and nephrectomy had been done on the opposite side. The patient was in a state of uræmia, and operation was deemed inadvisable. It was undertaken, however, on the insistence of the family, and the patient made a good recovery. Twice during the next 5 years he returned, was operated on for recurrence of the stone, and returned to his occupation each time.

In the same year, Judd reported a case, that of a woman aged 32 years, in which resection of the upper third of a solitary kidney was done in order to remove an abscess containing stones. Accurate records were kept before and after the operation which show that at the time of operation, renal function was definitely interfered with. After 2 months, the concentration of urea in the blood returned to normal and remained normal thereafter. Five months following this

[1] Submitted for publication April 21, 1930.

resection of the kidney, the patient became pregnant and 7 months later gave birth to a child who lived 14 days.

That multiple, consecutive operations may be successfully undertaken on a solitary kidney of good function is further evidenced by the reports of such cases by Babcock, Albarran, Squier, and Hinman and Gibson.

Keyes' report of 6 cases in which he had performed operations on a solitary kidney, with recovery in all, is the latest report in the literature. In 2 of the cases, multiple operation had been done successfully on a solitary kidney.

In 2 cases reported by Rosenkrantz, in which nephrectomy had been done for tuberculosis, external inguinal ureterostomy was safely performed on the ureter of the remaining kidney. Recently Coffey described two successful cases of transplantation of the ureter from the remaining kidney into the sigmoid in patients whose opposite kidney had been previously removed for tuberculosis. In 1926 Hunt transplanted successfully the ureter from a solitary kidney into the sigmoid for the relief of exstrophy of the bladder. Ten days later the bladder, which was carcinomatous, was excised and the patient made a good recovery.

The incidence of congenital absence of one kidney was described by Hennessey as occurring once in 1,000 cases, and by Campbell, as once in 1,600 cases. This is of interest in view of the fact that in Battle's case left nephrotomy was done for relief of obstructive pyelonephritis in a girl, 18 years of age, whose right kidney was congenitally absent.

Numerous cases of operations on the remaining kidney are also to be found in the foreign literature. In one of the cases reported by Haebler, in 1920, in which the anuria was the result of stenosis of the ureteropelvic juncture, a plastic operation, consisting of resection of the larger part of the pelvis and of the strictured region was done. Siedner, in 1925, reported 3 cases from von Lichtenberg's clinic. Obstructive suppression of urine in one case was due to a large anomalous renal vein. The vein was severed and nephropexy was done because of the low position of the kidney, with complete relief of symptoms. A stone was the offender in each of the other cases. Cases have been reported by Chwalla, Rosenstein, Siedner, and Cifuents. These authors emphasized the grave importance of the appearance of stone in the remaining kidney after nephrectomy on account of ureteral obstruction and consequent anuria. Because of the uncertainty of prognosis in their cases attendant on operations on a solitary kidney, they advocated, first, the passage of a ureteral catheter past the stone. Many times this is sufficient to relieve the obstruction. When this fails, nephrotomy, in their opinion, is preferable to pelviolithotomy. In their experience, the formation of stone in the remaining kidney, after nephrectomy, is of more or less frequent occurrence, and is variously reported at from 3 to 17 per cent. Such has not been the experience in the clinics of this country; for example, in 1917, W. J. Mayo stated: "Stone formation or reformation in the remaining kidney after nephrectomy is an uncommon occurrence in our series."

COMMENT ON CASES

In the 52 cases from The Mayo Clinic which form the basis of this review, operation was done in the period from November, 1911, to January, 1930. The incidence of operations on the solitary kidney occurred twice as often in males as in females, and in 75 per cent of the cases occurred in the third or fourth decade of life. Multiple operations on the solitary kidney were done in 6 cases, in all of which operation was successful. Four of these were for recurrent stone.

In 45 of the 52 cases, operations were for removal of urinary calculi; the 7 remaining were for conditions other than stone. Of the 45 cases of lithiasis, the stone was removed from the kidney in 34 and from the ureter in 11. In this group, there were 6 deaths following removal of stones from the kidney. In the 6 cases in which death occurred, operation was undertaken as an emergency procedure when obstruction and infection had manifested themselves to such a degree that immediate operation was necessary. In each case, partial renal insufficiency was evidenced by an accumulation of more than 40 milligrams of urea in each 100 cubic centimeters

of blood, by excretion of phenolsulphonephthalein of less than 30 per cent in the urine in 2 hours, and by a marked degree of renal infection, as evidenced by the presence of pyuria (pus graded 3 to 4). In each of these cases, failure to recover was the result of loss or absence of renal function in combination with marked renal infection; the patients died in a state of uræmia. Therefore, the necessity of early removal of a calculus in a solitary kidney before the onset of obstruction, of reduction in function, and of anuria with pyelonephritis or pyonephrosis is apparent.

All of the 11 patients from whom stones were removed from the ureter of a solitary kidney recovered. Four of these patients had complete urinary obstruction; two others had had anuria, lasting for 24 hours before admission. Where possible, an attempt to catheterize the ureter was made, and the concentration of blood urea was allowed to diminish before operation. One patient was aged 73 years; another, 50 years. In 8 instances, the stone was lodged in the lower third of the ureter.

In cases in which operation was undertaken for stone, pelviolithotomy was done in 24 instances; ureterolithotomy, in 10; nephrolithotomy, in 7; nephropelviolithotomy, in 2; pelvio-ureterolithotomy, in 1; ureteral meatotomy, in 1; and resection of the upper pole of the kidney, with removal of stones, in 1. Since in 45 operations on the solitary kidney or its ureter, for stone, there were 39 recoveries and 6 deaths, the mortality rate was 13.3 per cent.

In 7 cases, operation was done on the solitary kidney for conditions other than stone; there were 3 recoveries. One instance of recovery was in the case in which ureteropyeloneostomy was done and which has been mentioned previously. In another case, following urinary suppression of 5 days' duration, right pelviotomy was done for acute hydronephrosis with infection, a condition caused by an anomalous renal vessel. The vessel was divided and the patient recovered. Two years previously, the left kidney had been removed because of hydronephrosis with infection. In the third case, permanent nephrostomy was performed in 1920 because of pyelonephritis. The 4 patients who succumbed had irreparable disease of the renal parenchyma associated with cortical abscesses; in 2, decapsulation was undertaken without benefit. In the 2 other patients, following nephrectomy for tuberculosis, transplantation of the remaining ureter into the sigmoid was done for the relief, respectively, of intense tuberculous cystitis and of scrotal, urinary fistula.

COMMENT AND SUMMARY

A review of the literature, and a series of 52 cases from the records of The Mayo Clinic, in which operations were done on the solitary kidney or ureter, would indicate that the risk of death from such operations, undertaken for the removal of stones, was approximately 13 per cent. The operative risk in these cases was the result of delay, during which decreased renal function and renal infection had occurred. Evidence of this is seen in the review of the cases of 6 patients, who died following operations on the solitary kidney for stone. In all of these cases, renal function was abnormally low. In addition, the urine from the kidney in each of these 6 cases contained a maximal amount of pus (graded 3 to 4). Delay in operating on a solitary kidney until urinary obstruction with anuria had occurred, definitely increased the mortality rate of operations in such cases. The risk of operations on the solitary kidney is dependent on its function and the degree of infection. Results in such cases are somewhat dependent on the size and number of stones present. When the stone or stones are of large size, the possibility of a persisting urinary fistula must be taken into account.

Reports in the literature and a study of cases seen at the clinic would indicate that in the presence of satisfactory function of the remaining kidney, without abnormal infection, multiple operations can be safely undertaken on the solitary remaining kidney, with the expectation of satisfactory results. Although prognosis may seem to be almost hopeless because, as the result of delay, anuria and impending uræmia are present, operation should be undertaken; in cases of this type recovery has occurred. We have

been able to find in the literature less than 10 cases in which multiple operations were done on the solitary, remaining kidney. In these cases, together with the 6 herein reported, recoveries occurred in all. This bears out the early experimental observations of Tuffier, and the clinical observations of Babcock and of W. J. Mayo, that some persons can maintain not only life but working power with as little as half of a normal kidney.

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CLINICAL SURGERY

FROM THE CLINIC OF THE CITY HOSPITAL OF THE HAGUE

PERIDUODENITIS

JAN SCHOEMAKER, M.D., F.A.C.S. (HON.), THE HAGUE, HOLLAND

LAST year when Clairmont discussed peritoneal adhesions before the German Surgical Society, he mentioned periduodenitis but he did not enter into a discussion of its characteristics. Much of his material was supplied him by von Eiselsberg, Kuettner, Payr, and Schmieden, but none of these surgeons definitely interpreted the pathological significance of this condition, which presents cord-like or membranous adhesions between the duodenum, stomach, liver, gall bladder, and transverse colon; in other words adhesions in the space which the French call *carrefour sous hépatique*.

It is evident that these adhesions can be divided into two types. They may be cord-like structures or ligaments of varying size binding together the organs mentioned or they may be delicate, thin, spider-web like veils. The latter type is most commonly found on the duodenum from which it spreads out to the large and small omentum. On rare occasions the adhesions spread to the pylorus but almost never involve the stomach.

In the first group, the adhesions are usually secondary to an active or healed inflammation of the gall bladder, to ulcer of the stomach or duodenum, or to a previous operation in this region. They may even be considered secondary to appendicitis. The second type of adhesion is called by Duval the "essential type." Some surgeons believe that the "red membrane" present in such cases is the anatomical basis for a definite, classic clinical picture, while other surgeons believe that the symptoms are secondary to the stenosing effect of the membrane upon the duodenum. The form described first, the secondary, is well known to all of us but we are more or less certain that it is of relative unimportance.

The adhesions which are found during a cholecystectomy or stomach resection and which may be causative factors in the symptomatology, we always separate knowing full well that they will reform especially if the abdomen is drained, but we no longer believe that these new adhesions will lead to future complaints. However, I have seen one case in which the symptoms were referred to the site of adhesions whereas the primary etiological focus was far removed.

This happened in a woman 34 years of age who 4 years ago had a left sided pleurisy with effusion probably of tuberculous origin. The gastric symptoms began after the pleurisy had healed. She complained of epigastric pains which were worse at night and which radiated both to the left and right sides. Belching, occasional emesis which once was blood tinged, sour regurgitation, and obstipation were also present. Physical examination revealed a small well-poised woman. The thorax was negative and the pleurisy apparently completely healed. The epigastrium and gall-bladder region were extremely tender to palpation but the remainder of the abdomen was negative. Functional gastric analysis showed normal acidity; the stool was negative to 4 benzidine examinations. X-ray examination showed the duodenal bulb always distorted and never completely filled; the gall bladder negative with no calculi present. The X-ray diagnosis was duodenal ulcer or periduodenitis.

The patient insisted on operation as she had had symptoms for 4 years which had not been relieved by medical treatment. Dense membranous adhesions found between the liver and parietal peritoneum immediately suggested that this was not a true case of periduodenitis. Similar adhesions and cord-like bands were found between the liver and transverse colon which when separated exposed a normal non-distended gall bladder containing no calculi. The stomach and duodenum were negative, neither ulcer nor gastritis being found. There were still more adhesions which covered the cæcum and appendix. These adhesions were firmer and more irregular than the pericolic membrane frequently found over the cæcum and called Jackson's membrane. The appendix was removed because it was thicker than normal. Histological examination revealed an occasional tubercle below serosa of the appendix. The patient recovered from the operation and has remained perfectly well.

In this case it was demonstrated that tuberculosis of the appendix was the primary cause of the adhesions and it is obvious that the symptoms were localized at the site of the adhesions. From this case one may draw the analogy that secondary periduodenitis may lead to symptoms which disappear upon removal of the etiological cause.

To me, the essential type of adhesions are more interesting than the secondary type because in them we find a spider-web like veil upon the duodenum but no etiological factor in the duodenum, gall bladder, or stomach.

Has this finding any pathological significance? Duval believes that this veil is congenital and it is of pathological significance only when it causes duodenal stenosis which leads to symptoms. Morris, Appel, Arbuthnot Lane, and Deaver believe that the membrane is of inflammatory origin and that a periduodenitis which is localized only to the periduodenal region is responsible for the many symptoms. Doberer suggests gastritis as an etiological factor. Zander considers pancreatitis. Reischauer holds that adhesions and ulcers are equally responsible together with the nervous disturbances they cause. Anaphylaxis to specific proteins in the diet is a factor which should be considered in the same light as duodenal ulcers which follow burns. He suggests the name "asthma duodenale" for this syndrome of periduodenitis.[1] Gregory Cole considers it unimportant whether this membrane is congenital or due to localized inflammation of the peritoneum and thus dismisses the whole subject.

I believe, however, that a correct understanding not only of the etiology but also of the practical significance of this condition is not only of scientific but of practical value.

In our discussion we shall first consider the clinical findings in periduodenitis. In those cases in which the periduodenal membrane is present, I find that the patients always give a history of gastric distress which would seem to be caused by a peptic ulcer, but in which there is always something which makes the picture atypical. The patients complain that pain in the epigastrium always follows eating and that this pain develops immediately after taking food. The pain has a certain periodicity typical of ulcer; nocturnal pains are less frequent; typical hunger pain is absent; warm milk does not afford complete relief; emesis occurs occasionally and hæmatemesis is not infrequent; all the patients have lost weight; proper dieting does not afford the immediate relief which we have learned to expect in ulcer cases, but rest always alleviates the symptoms. If the patient returns to work the symptoms immediately reappear and the psychic factors seem to be important. It is interesting to note that there are more young men in this group of patients than women.

There are practically no objective findings. Usually there is tenderness in the epigastrium a little to the right of the midline; gastric acidity is usually high; in our series the benzidene test was positive only once; the X-ray findings always showed a deformed bulb suggestive of ulcer but in the absence of other X-ray ulcer findings the roentgenologist diagnosed adhesions but could not definitely diagnose ulcer; the stomach itself was normal and there was no retention.

The stomach and gall bladder were found at operation to be normal but there was a firm, very red membrane on the duodenum. On two occasions I was definitely able to establish the fact that at its distal border the membrane was firmer and exerted mechanical pressure upon the duodenum. On another occasion the membrane was so dense that it had stretched the duodenum to its limit. In all the other cases, the membrane was so thin that it could not have had any mechanical effect and was responsible only for the hyperæmia or redness with which it was associated.

I have observed this membrane for a long time and believe that two different factors enter into its etiology. The first is the pericolic or the so-called Jackson's membrane. I once believed that this pericolitis was of grave pathological significance and consequently when present would frequently resect the colon, which procedure taught me that the membrane had a classic localization—it begins just above the cæcum but does not bind it down, spreads over the ascending colon until it reaches the hepatic flexure, whence it turns left for a short distance of about 10 centimeters and then proceeds upward to join the spider-web like veil on the duodenum—the periduodenitis. It is particularly significant that the membrane is limited precisely to the point where the large bowel begins and in fetal life is adherent to the underlying structures. This would suggest strongly that the membrane is in some way secondary to embryonic or fetal structural growth. Examination of fetuses confirmed this opinion, for 3 of 7 studied showed a fine spider-web beneath the liver which involved the liver, gall bladder, duodenum, and colon. This spider-web demonstrated *en miniature* what is found in essential periduodenitis, but there were present in addition fine band-like adhesions which many authors call secondary periduodenitis.

The second factor in the etiology of this red membrane is the so-called red stomach. I described a syndrome in 1925[2] which closely resembles periduodenitis. The patients are usually operated upon under an erroneous diagnosis of peptic ulcer, but at operation there is found the characteristic redness of the pyloric antrum. The

[1] Laqua. Beitr. z. klin. Chir., cxlviii, Hft. 2.

[2] Surg., Gynec. & Obst., 1925, xl, 305.

location of this redness is always typical; it covers the entire pyloric antrum and ends medially very abruptly at the juncture of the pylorus and body of the stomach (corpus ventriculi). The duodenal edge is not always sharply limited but occasionally extends over beyond the duodenum. When this occurs, the duodenum itself is not red but the veil previously described.

Now in these three conditions—pericolitis, periduodenitis, and red stomach—various clinical and pathological findings are common to all.

The redness, the hyperæmia, is pathological but does not mean inflammation. I have examined histologically every colon with a Jackson's membrane which I have resected and have always found marked capillary engorgement of the capillaries in the serosa, but no leucocytic infiltration or œdema, no new connective tissue formation, and nothing abnormal in the deeper layers of the bowel. And when I resected a red stomach with the mistaken diagnosis that it was ulcerated due to a history of gastric hæmorrhage, the findings were exactly the same as those found in the colon. The mucosa, submucosa, and muscularis were absolutely normal but there was marked hyperæmia of the serosa. The large blood vessels as well as the capillaries are dilated and filled with blood, œdema and infiltration are absent and when the glands on the greater curvature are enlarged they also show only a hyperæmia without inflammation. There is, therefore, no similarity between red stomach and gastritis.

But these three, pericolitis, periduodenitis, and red stomach have several clinical findings in common. First, the pain is as a rule severe and localized to the hyperæmic area; further, diet has no effect upon the duration and character of the pain; rest always affords relief, and, finally, psychic insult always aggravates the symptoms.

All my patients were of a nervous type. A few were cured by surgery but in the majority the symptoms returned—a very significant factor pointing to the nervous basis for this syndrome. I am convinced that we must consider the periduodenal membrane as congenital but that the hyperæmia is definitely associated with the onset of symptoms and that the connection with the nervous system is still to be found. In these cases the vegetative nervous system should play a most important rôle. We are tempted to speak of vagatonias or sympathico-atonia, but to surgeons these words have too hypothetical a sound.

The practical question is—what shall we do to relieve a patient with a periduodenitis?

My opinion is that once the correct diagnosis is made surgery is contra-indicated and the treatment should consist in rest, suggestive therapy, antinervine, and diathermy to the epigastrium As a rule, however, this procedure is not practical. The patient usually has been treated for a long time without success by an internist and finally as a last resort is operated upon for fear an ulcer has been overlooked. An ulcer is not found, however, but the periduodenitis is discovered—what then?

The first thing to determine is whether this periduodenitis is essential or secondary. When most of the adhesions are cord-like and irregular and when the majority of them extend from the duodenum and liver to the gall bladder instead of to the transverse colon, we can be sure that the periduodenitis is secondary and turn our attention to the gall bladder first. In treating these adhesions it is important to remember that Duval has described many such adhesions as congenital and has considered them as ligaments of no pathological significance.

If however, we have to deal with an essential periduodenitis with a veil on the duodenum, one operation is absolutely contra-indicated and that is a gastro-enterostomy. If this is done the patient not only is not relieved of the old symptoms but develops new ones, especially the vomiting of bile. The first thing to determine is whether the edge of the membrane is dense and firm enough to constrict and stenose the duodenum. If it does this it should be resected. Taylor, Duval, and Roux believe that its removal is of marked importance.

I know that such a constriction may occur but it is the exception rather than the rule. In 3 cases I removed this constricting band with an excellent result but in 100 cases no stenosis was present. In the non-stenosing type of case, the abdomen may be closed without further surgical interference and the patient treated as any other nervous patient, or a duodenal exclusion may be performed.

If pain really comes on immediately after eating and disappears as soon as the stomach is empty, we may conclude that the pain is secondary to the passage of the food through the duodenum. In such a case, the stomach should be separated from the duodenum which is then closed and the stomach is united to the jejunum. In 2 of the 3 cases in which I have done this the results were excellent but in the third patient exactly the same symptoms are present as before operation, all of which is not very encouraging.

Once we are convinced that the nervous element is the predominating factor, and this is true in most of these cases, it is obvious that

intra-abdominal interference is contra-indicated. Although surgery does not in itself accomplish much it is of some little value in that it convinces us of the absence of ulcer and the patient can then be treated more intensively by psychic therapy.

The following history is a typical example of this technique or procedure and is classic for many other patients in my series.

A girl, 29 years of age, was admitted to the hospital in 1926. Abdominal, gastric, and nervous complaints had been present for many years. Appendectomy 8 years ago revealed no pathological changes and gave no relief. In 1926 she had severe pains in the epigastrium, and was convinced that adhesions were responsible for these symptoms. A laparotomy revealed a very red pyloric antrum, and on the duodenum a membrane which was removed. The gall bladder and the rest of the organs were normal. After operation the patient still complained of moderate distress but psychic therapy could relieve it and the patient was soon in excellent physical and psychic condition.

Three and one-half years after the operation she says: "I am much better than before the operation. Indirectly, the operation helped me very much. I now know that I am able to overcome my symptoms and find I can actually do this. I have started to work again and am at present in excellent condition despite two relapses which occurred after psychic upsets."

I believe that we will be able to help our patients by just this type of treatment and if we cannot do this ourselves, we must teach either the family physician or a skilled neurologist to do so.

FROM THE SURGICAL CLINIC, GUY'S HOSPITAL

OBSTRUCTIVE JAUNDICE

R. P. ROWLANDS, O.B.E., M.S. (LOND.), F.R.C.S. (ENG.), LONDON, ENGLAND
Surgeon to Guy's Hospital

JAUNDICE, due to obstruction of the common bile duct or of the common hepatic duct, is generally defined as obstructive; it has to be carefully differentiated from that due to diseases of the liver and small bile ducts. Its causes are numerous and varied, as may be seen from the following rough but convenient classification: (1) those inside the common bile duct, (2) in the wall of the duct, (3) outside the duct.

Inside the duct. Here the causes may be stone, blood clot, hydatid, slough, liver fluke, round worm. Of these, stone is infinitely the commonest, but I have removed organized blood clot, hydatid, and a slough, which were obstructing the common bile duct. The slough had passed through a dilated cystic duct after cholecystostomy for the relief of acute cholecystitis; it contained a catgut suture.

In the wall of the duct. There may be stricture, following operation or injury; kinking of the duct; papilloma; adenoma, or carcinoma in common hepatic duct, in common bile duct, or at duodenal papilla.

Outside the duct. Here there may be enlarged glands, especially malignant glands; carcinoma of the pylorus; any large abdominal tumor; aneurism; pancreatic cyst; hydatid cyst; renal growth, such as hypernephroma; any of which may obstruct one of the main bile ducts.

INDICATIONS FOR OPERATION

I advise an operation in all cases of obstructive jaundice in which no bile reaches the bowel, and the serum bilirubin remains well above the normal, if the patient is well enough to stand the operation, for in spite of all improvements the differential diagnosis is so difficult and uncertain that grave mistakes are frequently made. By accepting too readily the diagnosis of malignancy, we may either miss the opportunity of curing the patient by removing an unsuspected stone, which by no means always causes colic; or of correcting the jaundice with its intolerable itching, by adopting some form of internal or external drainage for the bile. This also prolongs life and makes it far more enjoyable. The risk of the operation is small compared with the great benefits it may confer.

At the best, the patient may be cured by the operation; at the least, he will nearly always be rid of his jaundice with its maddening torture of itching, its anorexia, wasting, and mental depression.

When the gall bladder is enlarged, it is almost certain that the jaundice can be overcome without the miseries associated with a cutaneous biliary fistula.

DANGERS AND POSSIBLE COMPLICATIONS

Bleeding used to be the chief danger of operations for jaundice. Fortunately, it can now be almost completely avoided by careful preparation of the patient before the operation, and by ligaturing every bleeding point at the operation.

Suppression of the liver functions is another danger, which may be very largely met by the careful preparation and after-care of the patient.

PREPARATION

Operations for the relief of jaundice are never so urgent as to prevent thorough preparation of the patient and rest in bed for several days on a careful diet. If the blood does not clot in the normal time, 5 cubic centimeters of a 10 per cent solution of calcium chloride are injected intravenously for 3 or 4 days before the operation and until the normal clotting time is restored. Liquids and glucose are freely administered to restore the liver functions and a light diet consisting chiefly of predigested food, such as Benger's, is given to restore the nutrition. The bowels are gently opened and the colon washed out the day before the operation. After the bath, the skin is prepared by painting with tincture of iodine, picric acid solution being avoided on account of the frequent irritability of the skin.

TECHNIQUE

A long right paramedian incision is made, beginning at the upper end of the epigastric angle and extending a little below the umbilicus. The rectus sheath is opened an inch from the middle line and turned inward, and the rectus muscle is drawn outward. This incision gives the best access to the common bile duct and causes the least bleeding. Every bleeding vessel, however

Fig. 1. Cholecystogastrostomy. Showing the position of the incisions in the stomach and gall bladder. The common bile duct was obstructed by a carcinoma of the head of the pancreas.

small, is tied with fine catgut. The deep layers of the rectus sheath and the peritoneum are incised vertically to a sufficient extent, but this incision is at least 2 inches shorter than the superficial wound, which makes it far easier to close. The abdomen is systematically, but rapidly explored for any sign of disease which may have a bearing upon the jaundice, such as carcinoma of the colon; then the liver, gall bladder, and bile ducts are examined with minute care to ascertain the exact cause of the jaundice. In most cases, the gall bladder is enlarged and the common bile duct distended. The duct is carefully palpated for stone, especially in its lower reaches about the ampulla of Vater.

The selection of the most suitable operation is now made after due consideration. Before the actual operation is commenced, the abdominal wall and the neighboring viscera are carefully protected from contamination or injury by moist gauze packs.

Choledochostomy. In some cases, it is necessary to open the common bile duct in order to make certain if there is or is not a stone in the bile duct. If a stone is found, it is backed whenever possible and removed through an incision made in the supraduodenal part of the duct, but in some cases, when firmly impacted, it has to be removed

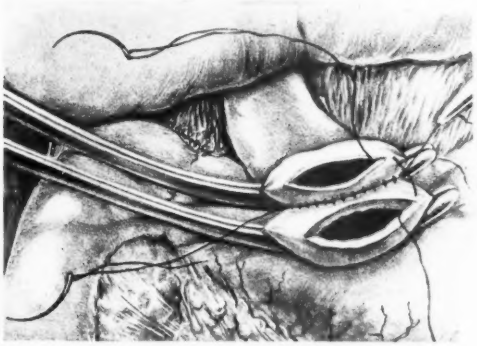

Fig. 2. Cholecystogastrostomy. Showing the insertion of deep and superficial continuous sutures of fine catgut.

by the retroduodenal or transduodenal routes. Occasionally within the common bile duct a small hydatid cyst or débris, a papilloma, or a slough may be found and removed.

Cholecystogastrostomy. When the head of the pancreas is enlarged, it is palpated with care in the hope of finding a stone in the ampulla or at the duodenal papilla. The harder the pancreas, and the more localized the swelling, the more likely is it to be due to malignant disease. Softer and more diffuse enlargements are commonly due to chronic pancreatitis. Rarely is it wise to remove a piece of the pancreas for microscopic section for this may cause unnecessary danger from bleeding, and does not assure the establishing of the diagnosis. (Fig. 1.)

When the cause of jaundice is irremovable and the gall bladder is distended with bile, cholecystogastrostomy is indicated. It is far better, easier, and safer to shortcircuit the gall bladder to the stomach than to the duodenum, jejunum, or colon. Ascending infection of the liver is also less liable to ensue after this operation.

It has been well established by clinical and experimental surgery that the discharge of all the bile into the stomach does not interfere in any way with gastric digestion.

If the gall bladder is very tightly distended, the bile is aspirated, for this makes the anastomosis much easier and safer. Soft curved clamps are placed upon the fundus of the gall bladder and upon the front wall of the stomach 2 inches to the left of the pylorus, so that the passage of food through the latter may not be interfered with (Fig. 2). The anastomosis is then made with two continuous fine catgut sutures. As the stoma is apt to contract, it is important

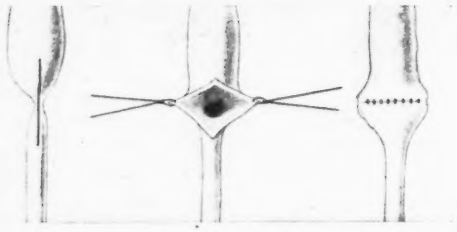

Fig. 3. Operation for stricture of a bile duct.[1] A longitudinal incision through the stricture is converted into a transverse one.

to make it at least an inch in diameter; flaps of the greater and lesser omenta are fixed in front and around the anastomosis.

Cholecystostomy. In a few selected cases, especially of pancreatitis with cholecystitis and thick walled, contracted gall bladders in very ill patients, cholecystostomy is the operation of choice, and prolonged drainage has often proved successful in overcoming the inflammation of the biliary apparatus and pancreas.

Restoration of the bile duct. It is often possible to overcome a fibrous stricture of the bile duct by a plastic operation (Fig. 3) and occasionally the duct may be reconstructed after excision of a malignant stricture (Fig. 4).

Choledochoduodenostomy. When the gall bladder is, for any reason, not available for the anastomosis, the most convenient part of the common bile duct or common hepatic duct is joined to the duodenum. Here it is better to choose the duodenum because it is so near to the ducts (Fig. 5). Whenever possible, the lateral type of anastomosis is made, but the end-to-side method often has to be adopted, especially for the hepatic duct. A tube is inserted in the dilated duct, and the anastomosis is carried out by direct suture as shown in Figure 6. Throughout the operation every bleeding point is tied immediately. When the common bile duct has had to be opened for any reason, I always insert a tube to drain it or its close vicinity; this is brought out through a stab wound an inch below the tenth costal cartilage. The paramedian wound is completely closed in layers, continuous No. 2 catgut being used for the peritoneum and deep layer of the rectus sheath; four or five interrupted mattress sutures of strong catgut are used to approximate the anterior layer of the rectus sheath and a continuous suture brings the edges of this sheath accurately together. A continuous suture of fine black linen thread is used to close the cutaneous wound.

[1] I have to thank Messrs. J. and A. Churchill, the publishers of "*The Operations of Surgery*" for their kind permission to use Figures 3 and 4.

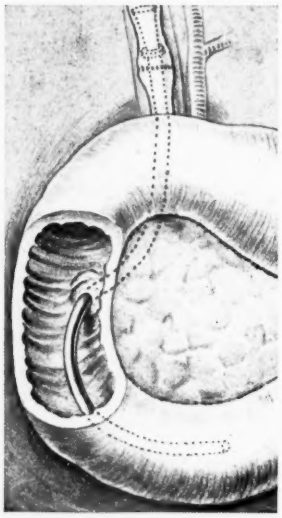

Fig. 4. Anastomosis of the common bile duct with the aid of a long rubber tube projecting into the duodenum. The upper part of the tube is enlarged and has a collar around it to keep it in place.

AFTER-TREATMENT

The management of these patients after the operation requires the greatest care. When the jaundice has been long continued, the wound is slow to heal and may break open, if the stitches are prematurely removed; therefore, I leave them in for 10 to 14 days and then hold the edges together with four bands of strapping for another week.

Restoration of the liver functions is encouraged by giving plenty of sugar and glucose by the mouth, or 5 per cent solution of glucose by the rectum or axillæ. In bad cases, glucose is given intravenously with great advantage. Remembering that the secretion of bile and perhaps pancreatic juice may be in abeyance for some days after the operation, Benger's and other pancreatized foods are indicated in early days after the operation, but the diet is increased to the normal as soon as possible in these wasted patients.

PROGNOSIS

The mortality from the operation of cholecystgastrostomy is now under 10 per cent and the earlier the operation is performed the lower the mortality. The risk of the operation is much greater in very chronic cases, especially when

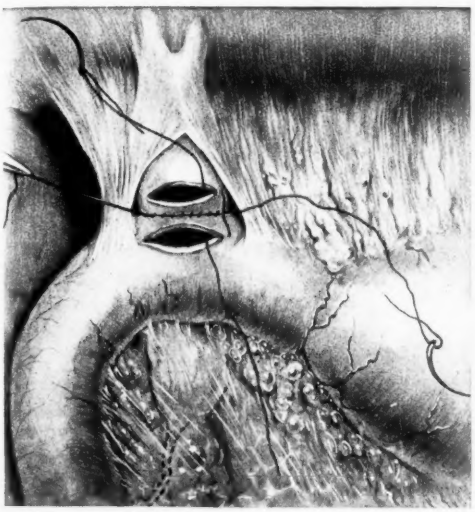

Fig. 5. Lateral choledochoduodenostomy. Flaps of the omentum are carefully sewn over the anastomosis.

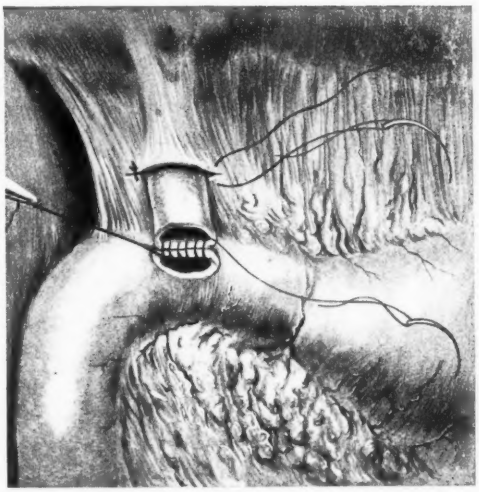

Fig. 6. End-to-side choledochoduodenostomy. A collared rubber tube is inserted to maintain the channel. In addition, flaps of the omentum are sewed over the anastomosis.

deep jaundice is associated with cholangitis, fever, and rigors. The ultimate prognosis is often doubtful, for the diagnosis between chronic pancreatitis and malignant disease of the head of the pancreas often remains uncertain at the end of the operation. The patient suffering from chronic pancreatitis generally improves continuously and puts on weight, whereas those afflicted by carcinoma of the head of the pancreas rarely survive more than a year after the operation, but as already stated, the relief obtained is very great. Subjects of irremovable carcinoma of the common bile duct may survive for 2 or 3 years after the operation. Some degree of ascending infection of the bile ducts probably follows most cholecystogastrostomies, but apart from returning obstruction from stenosis of the stoma, there may be no clinical symptoms of this infection of the liver. Occasionally there may be attacks of jaundice associated with fever.

CYCLICAL CHANGES IN VAGINAL MUCOUS MEMBRANE

SAMUEL H. GEIST, A.B., M.D., F.A.C.S., NEW YORK
From Gynecological Service, Mount Sinai Hospital and Pathological Laboratories, Mount Sinai Hospital

SINCE the discovery by Hitschmann and Adler of the cyclical variations in the uterine mucosa much progress has been made in our knowledge of the normal physiology of the female generative tract. Novak and Everett demonstrated cyclical changes in the tubal epithelium. These changes were initiated about the second day after the menstrual period. Schroeder and a group of others have shown that the uterine changes are dependent on the ovarian activity. Stockard and Papanicolaou described a cyclical variation in the vaginal epithelium of the rat. It was noted that the tubal changes started approximately on the second day after the menstrual period and that the uterine changes were first noted on the fifth day postmenstrual, while the vaginal changes, as will be shown later, were observed to begin on the seventh day. In other words, the initiation of the impulse for cyclical change descended from the tubes to the vagina in a wave-like manner. It was only natural that following the publication of Stockard and Papanicolaou investigators would immediately be led to believe that findings, analogous to those in the rodent, could be demonstrated in the human. Dierck published an excellent paper in which he tried to demonstrate that in the human female a definite cycle took place in the vagina. He described the vaginal epithelium at the height of the change as composed of three layers—a basal, a functional, and a cornification zone—and stated that he believed that the vaginal cycle kept pace with the cycle in the uterus and ovary. A gradual increase in thickness of the functional layer with a later development of the cornification zone separating the functional from the basal, and finally a desquamation of the functional at least in part, was noted. Following his article there were many other publications, some supporting his view, others differing wholly or in part. Lindeman has found changes in the vaginal epithelium but not of cyclical nature. He has described similar pictures not only in the functionating vagina but in menopause and in cases with amenorrhœa. Stemshorn likewise differs in his findings from Dierck. Stive agrees with Lindeman and Stemshorn in his findings, and differs with Dierck's interpretation of the cyclical variation in the vaginal mucous membrane. King made a study of the vaginal secretions, but was unable to find a definite cycle approaching that found in the rodent. Pankow finds that the cycle varies even in the individual case. He studied his cases by removing fragments of vaginal mucosa from the same individual during an entire period. He noted the first indication of three layers after the seventh day postmenstrual. He also noted a certain amount of desquamation during the intermenstrual period, as well as during the menstrual period. He believed, however, that there was a definite vaginal cycle. Adler agrees with Dierck, and found definite evidence of three layers most marked in the premenstrual period, and furthermore pointed out the presence of an excessively well developed functional layer in gravidity. In the postpartum period, during lactation, menopause, and before puberty there is no evidence of a functional layer, which facts strengthen the belief in a vaginal cycle. It is reasonable to believe that if the upper muellerian tract presented changes in its epithelium of cyclical nature and dependent on the ovarian hormone, the vagina likewise (the lower portion of the muellerian tract) would undergo a similar variation dependent on the same impulse. Allen was the first to suggest the relation of the ovarian hormone to changes in the human vagina. In castrated apes he was able to produce by means of injections of placental and ovarian hormones a real functional layer in the vagina. Dierck believed that he also demonstrated this relation between ovarian and vaginal changes in the human as Allen had in the ape. In a case of a castrated young woman, Dierck had been able, after injections of more than 9,000 mouse units of folliculin, to produce in this castrate a typical picture

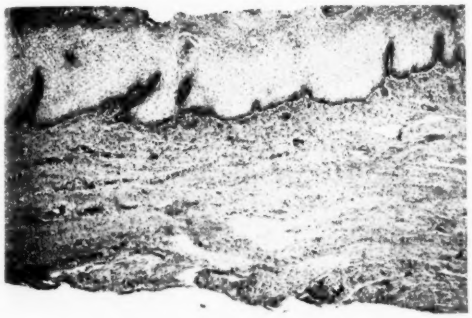

Fig. 1. Five days postmenstrual. No evidence of cornification zone. Result of recent desquamation. A bare surface. Vacuolization in basalis.

Fig. 2. End of first week postmenstrual. Vacuolization in superficial portion of the basal layer.

of the premenstrual phase in the vagina with its characteristic three layers, this effect being obtained after the beginning atrophy had set in due to the castration.

In a previously published series of papers on the morphology of menstrual blood (Geist), I pointed out that vaginal epithelium, either as individual cells or as plaques or cornified masses, was practically always present in the menstrual blood. Then in a subsequent study of smears from the vaginal mucosa, studied in collaboration with Guttmacher, we were led to believe that in the premenstrual and menstrual phases there was a tendency to what we termed "sheet desquamation," that is, a desquamation of vaginal cells not isolated, as is found in all phases, but in sheets or plaques of from five to hundreds of cells. These findings naturally led to a further study of the vaginal desquamation in its relation to the normal uterine and ovarian cycle. A series of 80 cases was studied. The ages of the women varied from 28 to 66 years; 15 were in the menopause, the duration of the menopause was from 1 to 12 years. Of those who were regularly menstruating the ages varied between 28 and 52. All of these women were in good physical condition, except for minor gynecological disturbances. There was no disturbance of the normal menstrual cycle. In other words, both the ovarian and uterine function seemed unimpaired. There were 27 specimens obtained during the so-called postmenstrual period, that is, from the first to tenth day; there were 16 specimens obtained during the interval from the tenth to twentieth day postmenstrual; and there were 8 obtained during the premenstrual period from the twenty-first to thirtieth day. The 4 other specimens were not utilized or studied; one was from a gravid woman and the 3 other specimens were not in proper condition for examination. The specimens were obtained by removing, during the course of anterior and posterior colporrhaphies, a large oval flap from the anterior and posterior vaginal walls. These flaps were well within the vagina so as to avoid that portion of the mucosa which may have been altered by exposure. In several cases punch specimens were removed at regular weekly intervals during two complete periods in the same woman. The material was fixed in formalin promptly and subjected to the usual histological routine examination.

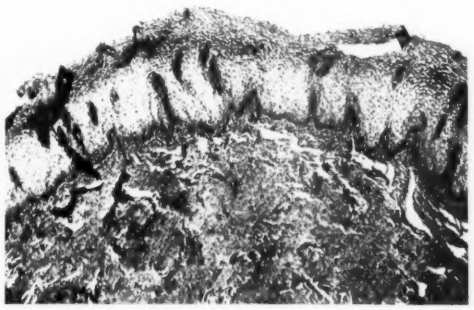

Fig. 3. Second week postmenstrual. Increased thickness of the basal layer. Marked vacuolization. Beginning flattening of superficial cells.

Fig. 4. Beginning of the third week postmenstrual. Basal layer showing vacuolization. Beginning flattening and disappearance of nuclei in the superficial cells. Indication of line of separation can be noted. (Intra-epithelial cornification zone.)

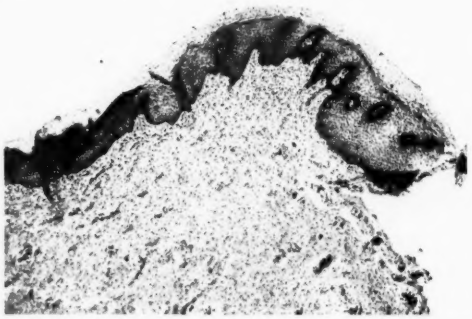

Fig. 5. Third week postmenstrual. Definite separation into two layers; basal layer well marked. Vacuolization not so noticeable. Very definite superficial flattened layer with poorly staining nuclei. Definite line of separation noted.

The study of this material has demonstrated that the vaginal mucosa undergoes a cyclical variation that keeps pace in a general way with the cycle in the ovary and uterus. In the first week the mucosa consists of one broad layer, the basal layer, with one or two rows of small dark staining cuboidal cells, with central nuclei surmounted by a row of somewhat paler cuboidal cells from two to three layers in thickness. Above this one finds a few additional rows of cells more oval or polyhedral, with round pale nuclei, the cell body showing a tendency to vacuolization (Figs. 1 and 2). (This vacuolization may represent glycogen). As one progresses to the second week postmenstrual, this upper portion of the basal layer becomes thicker due to the increase in the actual cell content. The cells become more vacuolated as they appear in the fixed specimen, the most superficial rows becoming slightly flattened, and the nuclei elongated (Fig. 3). In the third week this division into two layers, that is, the basal layer of cuboidal and vacuolated cells and the functional layer of more flattened ones becomes even more marked. The cuboidal cells of the basal layer become more cylindrical and the vacuolation more marked. At the same time the superficial, more flattened layer likewise increases in thickness, and the cells become more elongated and sinuous. It is occasionally noticed that between this flattened layer and the definite basal layer a small zone two or three cells in thickness becomes condensed, somewhat hyalinized, occasionally pigmented, and seems to separate the two main layers into discrete entities (Figs. 4 and 5). In the fourth week, that is, the premenstrual, this picture becomes more marked, and we have three distinct zones: a basal with cylindrical cells, the upper rows of which show slight vacuolization; a condensation zone termed by Dierck an intra-epithelial cornification zone; and a functional layer made up of many rows of flattened elongated cells with spindle shaped nuclei or with no nuclei. In this zone also one occasionally finds vacuolization (Fig. 6). At times in this period or even in the third week the upper zone (the most superficial one) is represented

Fig. 6. Third week postmenstrual. Differentiation into superficial, flattened layer of elongated cells, many without nuclei, separated from the basal layer by a beginning intra-epithelial cornification zone, basal layer in many places showing vacuolization.

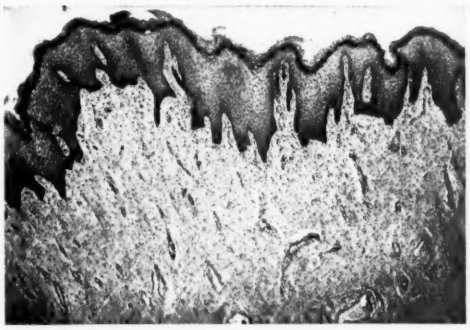

Fig. 7. End of third week postmenstrual. Definite line of demarcation between well marked basal layer and superficial flattened functional layer above. This demarcation line in this particular specimen is markedly pigmented.

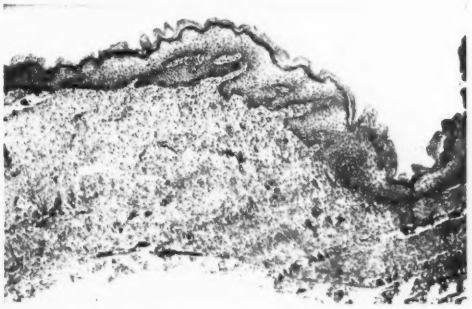

Fig. 8. Beginning fourth week postmenstrual. Definite division into two layers, superficial functional layer ready for desquamation, separated from the basal layer by a definite pigmented intra-epithelial cornification zone.

by a cornified mass of epithelial scales separated by a distinct narrow zone from the basal, and apparently ready to desquamate (Figs. 7 and 8).

All specimens, it must be emphasized however, do not show this cycle with all the characteristics described. Often certain stages are absent when one would expect their presence from the menstrual history. At the same time it is noted that in different parts of the same specimen the picture may vary. It is difficult with our present method of histological technique to differentiate the phases distinctly at all times. There is no question that overlapping of the various phases and definite variation in the cycle in some individuals, possibly depending on variations in the female sex hormone content, take place. That the cycle exists in the vagina seems unquestionable. It is only necessary to devise some better method of recognition to identify the different phases and their variations. It must be emphasized that cyclical changes cannot be identified in every specimen. In some they seem to be delayed, in others anticipated, while in other groups two phases may be present at the same time in different parts of the same specimen.

CONCLUSIONS

In conclusion it must be assumed that while there is a wide divergence of opinion, in general it can be stated that the vaginal mucosa undergoes cyclical variations probably dependent on the presence of an ovarian hormone; that at the present time with the usual histological methods available, it is difficult definitely to accord to each picture its proper place in the cycle, and that furthermore, as there are variations in the ovarian and uterine cycle with overlapping and individual differences even in the same patient, so too in the vagina the same variable condition prevails.

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DIAGNOSIS OF CONTRACTED PELVIS BY IMPRESSION METHOD[1]

DAVID S. HILLIS, M.D., F.A.C.S., CHICAGO

THE determination of the relative size of the fetal head and the mother's pelvis is one of the difficult problems of obstetrics. Much attention has been given to the study of the various types and sizes of contracted pelves, but, as Williams states, despite the existence of numerous methods devised for accurately determining the size of the head we are still without one that is thoroughly satisfactory. Since the head varies as much in size as does the pelvis, the reason for the difficulty in making this diagnosis is obvious. A successful method to determine this relationship must include a consideration of the size of the head as well as the capacity of the pelvis.

Perhaps the most rational method of making this measurement has been suggested by P. Mueller and modified by Monroe Kerr. This method consists in making pressure on the head, through the abdominal wall, with one hand above the symphysis to determine how far the head can be pressed into the pelvis and to decide whether or not it is meeting with bony resistance or is stopped by soft tissue. Monroe Kerr suggested the use of two hands above the symphysis and an assistant to determine the result of the impression. This method is not generally used because it is technically difficult and must be done under anæsthesia.

A modification of the Mueller maneuver is proposed. It is practically painless and requires no skill beyond that which may be acquired by the doctor in general practice. It is a diagnostic procedure which makes it possible at or before labor to separate all cases into classes: those in which it is known that the head will pass the inlet and those in which the mechanism is doubtful or impossible. It is not recommended as a substitute for the usual diagnostic methods but should be used in addition to them.

The application of this method presupposes a knowledge and use of the following facts: The important diameters of the head and the pelvis are the biparietal diameter and the true conjugate respectively. The successful passage of the head through the inlet depends upon the relative sizes of these two diameters. When the biparietal diameter has passed the true conjugate, bony resistance at the inlet has been overcome. When the lowest bony part of a moderately molded or unmolded head has reached a line drawn between the tips of the spines of the ischium, the biparietal diameter is passing the true conjugate. Allowance must be made for caput succedaneum and thickness of cervix or lower uterine segment in front of the head. If a head lies lower than this level or can be impressed below this point, it is positive evidence that no bony disproportion at the inlet exists.

The greatest number of serious pelvic contractions are found at the inlet. The cases in which the moderately molded or unmolded head can be impressed below or is found to lie below the ischial spines will rarely be found to offer impassable bony obstruction at the outlet.

With the use of this method it has been shown that the widely prevalent idea that the head at term cannot be pushed downward any appreciable degree with the cervix undilated and the bag of waters unruptured is untrue. In approximately 90 to 96 per cent of all cephalic presentations at term, the lowest part of the head can be impressed to or below a line drawn between the tips of the spines of the ischium. This number, of course, includes those cases in which the head already lies at such a level.

With the patient in the lithotomy position on a table, not too high, the examining finger in the rectum locates the tips of the ischial spines and notes the relation of the lowest part of the baby's skull to a line drawn between them. The hand on the outside is placed above the breech of the baby and is sunk as deeply as possible toward the mother's spine, *the forearm parallel to the long axis of the mother*. Pressure is then made on the breech toward the inlet and the descent of the head noted with reference to the interspinous line, allowance being made for the thickness of the lower uterine segment, the cervix or caput succedaneum if present. To avoid traumatism and pain the pressure is begun gradually and after the maximum is reached is slowly released.

If the head cannot be impressed to the spines, an assistant places the palm of one hand flatly over the middle of the baby's back to prevent flexion and the fingers of the other hand placed palmar surface downward above the head over the symphysis presses the head downward and backward in the axis of the inlet while the examiner makes pressure on the breech and notes descent with the internal finger.

[1]From the Department of Obstetrics and Gynecology, Northwestern University Medical School.

Fig. 1. Impression of the head without aid of an assistant.

Fig. 2. Impression of the head with aid of an assistant.

If impression fails with the aid of an assistant, a trial is made under a short surgical degree of anæsthesia.

With the use of the method in several thousand cases by internes in the prenatal clinic and in the wards at Cook County Hospital, there has never been observed bad effects of any kind whatsoever to mother or babe.

Three conditions in pregnancy are known to prevent impression of the head when no bony disproportion exists. These are incomplete development of the lower uterine segment, excess of liquor amnii, and lack of co-operation on the part of the patient. Further experience will no doubt reveal others which have not yet been determined. The best results are obtained the nearer to term the examination is made. The lower uterine segment reaches its highest point of development in pregnancy at term; this process is indicated by the progressive shortening and softening of the cervix. The impression is tried at each prenatal visit in the last month of pregnancy and final judgment can be made in most cases before term. Excess of liquor amnii prevents impression for mechanical reasons and must be given consideration in cases in which the head cannot be made to enter. Oversensitive patients may require anæsthesia, and the muscular relaxation is an aid in some doubtful cases in which voluntary resistance is not apparent. Not more than 4 or 5 cases in 100 require anæsthesia.

As each patient enters labor she is placed in one of two classes. In approximately 95 per cent it is known that the head will enter the pelvis and no bony obstruction will be expected. The 5 per cent remaining are those patients classed as having doubtful mechanisms and are given careful investigation. These patients are studied

Fig. 3. Station of the head before impression, above the spines.

Fig. 4. Station of head during impression, below spines. Patient at term not in labor. Bag of water not ruptured.

with special reference to amount of overriding of head, diagonal conjugate diameter, estimated size of baby, and measurements and type of pelvis. X-ray measurements of pelvis and head may be made if facilities permit. After labor has begun the method is used from time to time and a decision as to the necessity for abdominal delivery can usually be made before the time limit of safety for a cæsarean section has been passed. All patients in whom the head cannot be impressed below the spines at the beginning of labor should be managed with a view to possible abdominal delivery.

If, after a fairly early rupture of the bag of waters in labor, the head cannot be impressed to or below the spines a cæsarean section may be done at once and in our opinion with proper facilities at hand is justified.

Experience with this simple procedure has led us to believe that it is worthy of further development by general use to the end that practical working rules may be laid down to solve the important question of the relative size of the baby's head and the mother's pelvis.

NOTE.—This procedure was referred to and described in a paper by D. S. H. "The Obstetrical Forceps Operation" published in Virginia Medical Monthly, December, 1925.

PLASTER EMBEDDED SKELETAL TRACTION

USE IN TREATMENT OF FRACTURES

KELLOGG SPEED, M.D., F.A.C.S., CHICAGO
Presbyterian Hospital

FOR general use two types of skeletal traction are universally feasible. One type is the caliper, a modification of Ransohoff's ice tongs, built on the same mechanical principal and found ready for use in many hospitals. A few of these calipers have certain structural defects which limit their use. In some the sharp points which penetrate the skin and are buried in the bone for the skeletal grip are too broad in diameter, too short in length and insecurely fastened to the handle portion. In certain types these points are detachable, and they consequently become loose or unscrew easily, leading to insecurity. The axis at which they are attached to the handle is often mechanically incorrect. When they are attached at a right angle and enter the bone through the soft parts their skeletal grip is weak; they easily pull out; they bring all traction pressure to bear on the anterior surface of the point inserted into the bone. The axis of the skeletal grip of the caliper on the bone should be at an angle of 45 degrees to the long axis of the bone. The pull is then largely against the inserted point of the caliper in the long axis of the bone, and the harder the pull on the traction, the deeper the penetration, and the greater the security of the caliper point.

Any caliper, however, may pull out of the wound in the bone and soft parts. During movements of the patient, involuntary twitchings or spasm during sleep or by intention, the caliper may be jerked out of its set position. It is also true that the inserted skeletal grip point is subject to some rotatory movement in the skin and soft parts as the traction is steady in one axis and the leg is free to move in others. Such movement in the soft part wound invites irritation, the introduction of skin bacteria into the puncture wound, and may convey infection into the bone locally. Calipers have other mechanical restrictions—they may be too small to embrace the limb of a patient; the opening cannot be enlarged beyond a certain width. One additional factor mitigates against their use in some hospitals, namely their cost. To keep on hand a set of six or more calls for considerable investment. The technique of insertion is not easy; it cannot be well done even by some surgeons, and the casual operator often finds great difficulty in setting the skeletal grip with proper satisfaction.

A second type of skeletal traction in common use is the Steinmann pin. Just why this pin should be offered on the surgical instrument market as a bisected steel pin, sharpened at both ends, is not understood. A suitable piece of steel drill rod 7 to 10 inches long sharpened bluntly to a point like a lead pencil by turning down on an emery wheel will give a cheap source of supply. Pins of varying sizes can be thus made, to be kept on hand and to be used over again if desired.

Their advantages are—they are cheap, they can be procured almost in any town hardware store on a few minutes' notice, they can be made in advance out of rustless steel if desired. The pin once inserted through a bone for skeletal traction, remains quite firm; it does not turn or rotate in the wound; it will not slip or pull out; it makes a uniform pull on the bone at a right angle to the long axis of the limb; and it is very dependable especially for embedding in plaster of Paris.

The indications for the use of embedded skeletal traction by means of the Steinmann pin are varied. Primarily it is useful for traction on the leg.

In fractures of both bones of the leg there is difficulty in obtaining lost length either because of the heavy musculature, muscle spasm, or the delay in treatment with consequent swelling. The physician often finds that the short distal segment of the limb is hard to hold after the bones are pulled out to proper length so that a retention splint may be applied. A fracture table helps in many of these fractures, but one may fear pressure about the malleoli from the straps or bandages which hold the foot to the table foot piece. A pin inserted through the calcaneus will afford proper points on which the traction may be fastened and drawn up tightly to effect fragment reduction without running the risk of constricting pressure of the soft parts of foot or ankle. When a reduction is thus satisfactorily accomplished, plaster of Paris can be applied from upper thigh to toes incorporating the pin in the plaster. After the limb is released from the traction on the table the relationship of fragments remains as it was and the reduction is held without fear of plaster pressure on the soft parts, the pressure or pull being transmitted to the distal part of the leg through the pin by its skeletal grip.

This same aid may be useful in fractures of the femur at any level—even the neck—because the pin aids greatly in the traction down the long axis of the leg or in holding the rotation needed for inversion of the foot. Especially is embedded skeletal traction valuable in open fractures, débrided, and then encased in plaster of Paris.

Two other types of fracture in the leg are greatly benefited in treatment by embedded skeletal traction. One is fracture of the leg treated by open operation where no strongly supporting internal splint is used. By this is meant particularly old fractures of the leg with malunion or non-union, in which the bone surfaces are freshened, cleaned, and apposed, and no internal splint such as a metal plate or graft of bone is used to steady and hold the fragments together. If much tissue has been cut away from the tibia, the operator finds that he has to shorten the fibula to get an apposition for the tibia, that is he has to push up on the foot to bring bone surfaces together. An intramedullary splint of bone may be used as a guide to hold fragments in proper relationship, but it will not hold them together, and if there is no desire to use an internal fixation splint, which operation is rapidly going out of use, some means must be had to hold bone fragments in apposition.

The embedded skeletal traction accomplishes this admirably, used as a means of pushing the foot up and holding the distal bone fragments against the proximal fragments until the wound is closed and the plaster dressing is applied. By means of this security the patient may then be taken off the fracture table and bony apposition found to be satisfactory.

Another type of fracture often difficult to reduce and hold while the external splint is applied is lipping fracture of the tibia with or without dislocation at the ankle. Particularly in instances of posterior lip fracture of the tibia is it difficult to drag down the posterior lip of the tibia, to hold the ankle in reduction, to hold the leg flexed at the knee to relax the calf muscles while a suitable plaster dressing is applied. By means of embedded skeletal traction through the calcaneus these things can be easily accomplished and the patient saved the necessity of an open operation to attempt to fasten down the elevated posterior joint fragment of the tibia.

The technique of the insertion of the Steinmann nail needs no explanation here. It is done under strict aseptic precaution, the nail is driven through the selected bone as a nail would be through a plank, by means of a suitable hammer, a carpenter's instrument, not a toy hammer. Three sites are possible, the supracondylar area of the femur, the anterior surface of the tibia, and the calcaneus. The rules and technique of insertion have been given in detail by the writer elsewhere.

After the skeletal traction is applied, the skin puncture wounds made by the nail are covered with several layers of dry gauze dressing. If it is wished, over the dressings may be placed impervious waxed paper or cut out pieces of old sterilized rubber glove to keep the potentially septic moisture of the plaster of Paris from contaminating the wounds. Sheet wadding is applied over the leg, the position of which has been determined by the procedure undertaken to reduce a recent fracture by traction or to hold an old fracture in

apposition by open operation. If open operation or traction is to be used with the help of a fracture table, the insertion of the nail is the first step. After the nail is inserted the foot is bound to the table foot piece, the projecting ends of the nail being used as points of attachment, thus making the foot of the patient and with it the distal segment of the leg beyond the fracture level fixed in such a way that their position in any axis is under mechanical control.

When the position after open operation, traction, or push is satisfactory, as judged by direct vision or X-ray, the plaster-of-Paris dressing is applied in the usual manner; the nail is disregarded except to be sure it is well buttressed with plaster. After the plaster dressing has hardened, the leg can safely be taken from the table without fear of disruption of fragments or soft part pressure.

When the bone has healed the plaster dressing is cut open, the unpacking around the nail is carefully done, and the nail is extracted under aseptic precautions. The resulting wound heals kindly and promptly.

ADENOACANTHOMA OF THE UTERUS WITH METASTASIS TO THE POSTERIOR MEDIASTINUM AND LUNGS

ARTHUR STEIN, M.D., F.A.C.S., NEW YORK
Associate Gynecologist, Lenox Hill Hospital and Visiting Gynecologist, Hospital for Joint Diseases
AND
FRANZ TOREK, M.D., F.A.C.S., NEW YORK
Consulting Surgeon, Lenox Hill Hospital and Consulting Surgeon, Skin and Cancer Hospital, New York

THE case here recorded is of interest for two reasons: first, because all writers on the subject agree that adenoacanthoma of the uterus is a rarity; and, second, because a fairly thorough search of the literature has failed to reveal a case of this type of malignancy in which metastasis to the mediastinum and lung has occurred, although the tendency of all types of adenocarcinoma to metastasize is well known.

The case seems, therefore, to be unique.

CASE REPORT

Mrs. C. T., aged 42 years, first reported in May, 1927. She stated that she had had one confinement 18 years ago, at which time there were lacerations which had been repaired. About 15 years ago she had a spontaneous abortion and curettage. Menstruation had always been regular until 2 months ago; since then it had been prolonged, with spotting at intervals. She complained of a "bearing down sensation in the back," and also in the abdomen. She had lost considerable weight during the past year. A physician who had examined her 9 months previously told her that her uterus was slightly enlarged.

The general examination showed the patient to be very thin. The abdominal examination was negative. The abdominal walls were strong, and there was no tenderness over McBurney's point.

The vulva was normal; the vagina admitted two fingers. The cervix was markedly enlarged, elongated, and extremely hard; it pointed straight back to the hollow of the sacrum. The outer surface of the portio and cervix was normal in appearance. The body of the uterus was very hard, slightly enlarged, anteflexed, and movable. The adnexa were normal. A sound could be passed no further than the internal os, where it encountered an obstruction.

The tentative diagnosis was carcinoma of the uterus.

The patient was then examined under narcosis and a probatory curettage was done and a large amount of apparently adenocarcinomatous tissue was removed. Complete hysterectomy was, therefore, decided upon.

Operation. A total hysterectomy was performed in May, 1927. Through a midline incision above the symphysis the uterus and both adnexa were removed in the usual manner. The uterine cavity was not entered during the operative procedure. The cervix was found in close proximity and adherent to the bladder and was freed with difficulty, suggesting invading carcinoma. The appendix, being about 4 inches in length, was then removed; the stump was cauterized but not inverted.

Upon opening the uterus its entire wall, to a depth of 0.5 centimeter from the mucous membrane, was found to be invaded with carcinomatous tissue, every portion from the fundus to the internal os being involved.

Pathological report. Gross appearance. "The specimen in formalin consists of (1) several irregular pieces of material designated 'uterine curettings' and (2) a uterus in the fresh state with cervix already sectioned and with tubes and ovaries attached. The uterus measures 12 centimeters in length and about 7 centimeters in width. The outer surface is smooth except where torn by operative instruments. The lips of the cervix are slightly beaded but soft. On section the uterine wall measures 2.5 centimeters in thickness. The entire uterine cavity is filled with bloody, necrotic material which completely hides the endometrium. The latter is eroded in many places, especially near the cervical portion where the uterine wall is also involved. . . . The tubes are alike on both sides, being slightly injected and measuring approximately 10 centimeters in length. The fimbriated ends are patent. The ovaries are yellow in color, convoluted, and measure 3.5 centimeters by 1 centimeter. They are firm in consistency. . . . The third specimen consists of an appendix, measuring 6 centimeters by 4 centimeters. The serosa

Fig. 1. The uterus, removed at operation, its wall infiltrated with adenoacanthomatous tissue.

shows a few small injected blood vessels but no adhesions. The lumen is patent except at the distal portion, which is obliterated by fibrous tissue. Fæcal material is present. The mucosa is thin, the wall fibrotic."

Microscopic pathology. "Sections show adenocarcinoma of a type common to tumors of the body of the uterus.[1] The tumor acini vary in size, some being small while others are very large. They are lined with single or multiple layers of cells which in the larger spaces often show a tendency to form small secondary acini. In certain areas the cells have lost their glandular structure and are arranged in solid masses. Mitotic figures are numerous. The stroma is relatively scanty, consisting generally of delicate strands of vascular fibrous tissue. It is infiltrated with many inflammatory cells, small round cells predominating. Sections through the uterine wall show that the tumor extends rather deeply into the muscle. . . . The appendix shows a chronic productive inflammation, which in the distal part has resulted in extreme narrowing of the lumen and disappearance of the mucous membrane and lymph follicles."

Postoperative history. The patient progressed normally during the first week after the operation. It was then noticed that the vaginal discharge had a marked urinary odor, and the patient stated that there was a marked dribbling of water from the vagina. It was evident that a vesicovaginal fistula existed. Upon discharge from the hospital the patient was instructed to report at stated intervals. During the summer she was again admitted to the hospital and treated for left-sided pyelitis. As the vesicovaginal fistula persisted, closure was decided upon in August, 1927. The operation consisted in denudation of the wall of the fistula and the sewing up separately of the bladder mucosa, connective tissue, and vaginal mucosa, plain catgut being used except for the vaginal mucosa, which was sutured with chromatic catgut. A permanent catheter was inserted.

The pathologist's report stated that the tissue, which consisted of two small masses the largest of which was 4 centimeters in length and 1 centimeter in diameter, showed chronic inflammatory reaction.

Microscopically, the fragments showed a dense and relatively noncellular connective tissue diffusely infiltrated with round cells. *There was no evidence of malignancy or of tuberculosis.* Epithelial elements were not demonstrable in the sections, and a sinus tract was not found.

[1] Re-examination of the tumor after removal of the adenoacanthoma of the mediastinum showed it to contain adenoacanthomatous tissue.

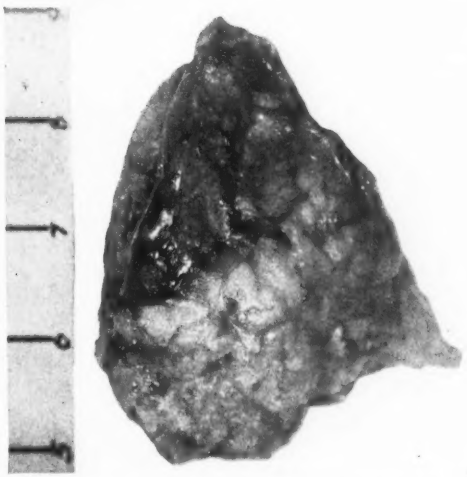

Fig. 2. The mediastinal tumor, which proved on microscopic examination to be an adenoacanthoma.

Seven months after the operation the patient had gained about 15 pounds. The pelvis was normal, there being no indication of any recurrence of the carcinoma. There was scarcely any leakage between the bladder and vagina, and later the fistula closed entirely.

The patient reported at stated intervals, and her condition remained perfectly normal until September, 1929, when she complained of pain in the stomach region, loss of appetite, and some difficulty in swallowing. Examination at this time was negative. The symptoms persisted, however, and in December, 1929, she stated that with care she had been able to eat small morsels of meat until November; since then only soft food would pass down. Her weight had decreased from 105 pounds in August to 90 pounds. She gave no history of lung trouble, did not cough, and had no pain in the chest; occasionally she felt her heart pound slightly.

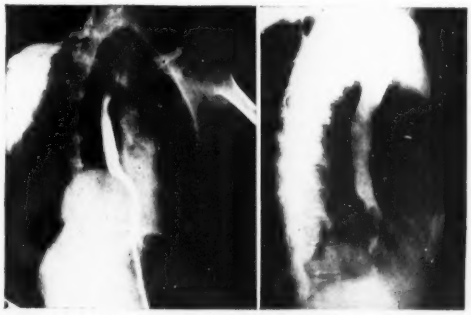

Fig. 3 (left). Roentgenogram of chest, showing metastasis in mediastinum, more on right side than on left.

Fig. 4. Roentgenogram of chest 2 weeks after removal of mediastinal metastasis, showing adhesions around lower part of œsophagus.

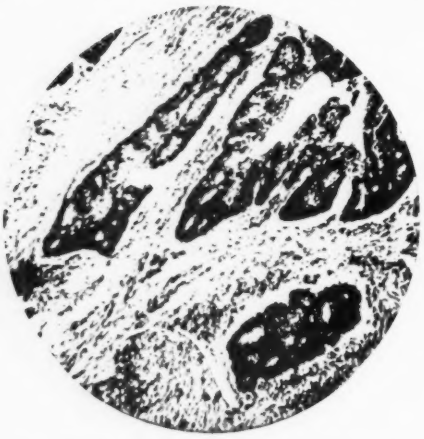

Fig. 5. Uterine tumor showing prevalence of adenocarcinomatous glands.

Fig. 6. Mediastinal tumor showing prevalence of squamous cell carcinoma (low power).

Examination revealed dullness low down on the posterior aspect of the chest, especially on the right side; on the left side there was dullness only close to the spine. Over the dull area the breath sounds were faint; above that area voice transmission was increased. An occasional râle could be heard on either side. Roentgenological examination of the gastro-intestinal tract was determined upon and carried out on December 26, 1928.

X-ray examination. Fluoroscopic as well as roentgenographic examination revealed a smooth, round, circumscribed mass in the right chest, appearing just above the right diaphragm and extending beyond the right border of the heart. It apparently arose in the posterior mediastinum. The tumor caused distinct pressure on the œsophagus and occasioned considerable obstruction. Above the point of constriction the œsophagus was somewhat dilated.

The stomach was atonic and markedly ptosed, the greater curvature being about 7.0 centimeters below the left iliac crest. There was no roentgen evidence of an organic lesion of the stomach. In the descending limb of the duodenum, however, a clearly defined diverticulum was observed. This sacculation was suspected of causing a degree of obstruction, as there was a large 6 hour, and a small 24 hour gastric residue.

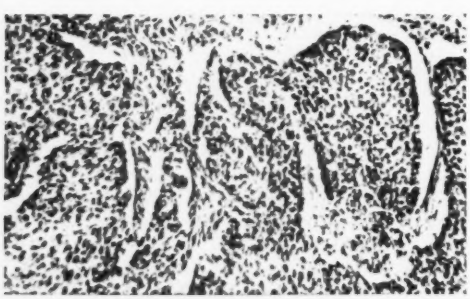

Fig. 7. Same as Figure 6 (high power).

The colon was ptosed and quite spastic.

Conclusion. The mass was first thought to be a dermoid cyst. When the clinical findings were revealed, however, the great probability of a metastatic tumor was the final interpretation of the shadows.

Operation. The patient was operated upon on January 30, 1930, for the supposed dermoid cyst of the mediastinum. She was placed on her left side, leaning slightly forward, with the right arm extended over the head. A posterolateral incision was made through the eighth interspace from the angle of the rib to the midaxillary line, and then extended from its mesial and downward corresponding to the eighth, ninth, and tenth ribs. The incision was carried to the pleura, but not through it, as it was intended to do most of the work extrapleurally. The parietal pleura was separated from the eighth and ninth ribs, well forward to beyond the anterior end of the incision; then it was separated backward toward the mediastinum and downward to the diaphragm. In the course of this procedure the eighth, ninth, and tenth ribs were cut about at their angles as the sites of the proposed cuts were freed from the parietal pleura. It soon became apparent that the mass was not a mediastinal tumor, but a tumor of the lung which had become firmly attached to all its surroundings, the firmest attachments being to the diaphragm and to the vertebræ. The dissection was nevertheless continued extrapleurally, because this gave a better guarantee of remaining outside the involved areas and because it was evident that a thin slice of the lung would have to be removed with the tumor and that the raw surface of the lung could be best dealt with after the tumor was excised. There was some spurting from the cut surface of the lung, which was caught and later closed by a continuous catgut suture. The pleura was then sutured wherever possible, but this could be done only partially because portions of it had to be sacrificed in the removal. The lung was inflated and the wound closed without drainage, No. 2 chromic gut sutures being used around the eighth and ninth ribs, chromic catgut for the muscles, and silk for the skin.

After the patient was returned to her room she was given a blood transfusion of 500 cubic centimeters. She

made an uneventful recovery from the operation and is now receiving prophylactic X-ray treatment.

March 27, 1930, vaginal examination showed there was no local recurrence. Patient still had difficulty in swallowing, apparently due to adhesions around the œsophagus.

Pathologist's report. Gross appearance. "The specimen, received in the fresh state, is designated 'mediastinal tumor and adjacent diaphragm.' It consists of two pieces of tissue. The larger piece measures 9 by 5 centimeters; the smaller, 7 by 3 by 0.6 centimeters. The smaller specimen fits tightly against one margin of the larger specimen. The large specimen is not encapsulated, but is fairly well circumscribed. The surfaces are ragged and irregular. On section the tumor is seen to be composed of a thin, interlacing stroma in which is soft, friable, almost gelatinous tissue. The tumor is very vascular and several areas of diffuse hæmorrhage are seen in its substance. . . . The small specimen from the diaphragm is composed of a pinkish-gray, soft, friable tissue, with a somewhat granular surface, which in section is of a more fibrous nature than the large specimen."

Microscopic pathology. "Sections of the peripheral portions of the tumor show a carcinoma composed, for the most part, of columns and islands of pavement epithelium supported by delicate strands of fibrous tissue bearing this with blood vessels of small calibre. The greater part of the epithelium shows neither intercellular bridges nor epithelial pearls. The constituent cells are usually small and hyperchromatic, though there are areas composed of larger cells which stain less deeply with hæmatoxylin. Mitotic figures are fairly numerous. In many areas, there are small masses or nests of differentiated squamous epithelium often showing central cornification or pearl formation. Included in the tumor are a few small spaces bordered by cylindrical epithelium or more or less well defined glandular acini. Near one surface of the tumor there are small islands of pulmonary tissue, and attached to the surface is a small quantity of atelectatic lung tissue. Toward the deepest part, the tumor shows extensive necrosis, sometimes with replacement fibrosis. In the newly formed fibrous tissue are a number of cholesterin crystal spaces often bordered by giant cells."

Diagnosis. Adenoacanthoma of the lung and posterior mediastinum secondary to adenoacanthoma of the uterus.

REVIEW OF LITERATURE

Adenocarcinoma of the uterus is classified by Ewing, who followed the plan of E. Kaufmann, into four groups: (1) malignant adenoma, (2) papillary adenocarcinoma, (3) alveolar carcinoma, (4) squamous carcinoma.

Of these, malignant adenoma is the most frequent form. It presents cords of pavement epithelium in which alveoli, pearls, spine cells, and hornification are not demonstrable. It is thought to have its origin in the endometrial glands, while papillary adenocarcinoma is believed to arise from the superficial endometrial epithelium.

Alveolar carcinoma is rare and is formed of small solid masses of cells forming occasional small alveoli. These, according to Ewing, are more malignant than adenomata.

He writes: "Squamous cells may form a prominent element in adenocarcinoma of the corpus and in rare cases they predominate over the glandular structure and produce a true adenoacanthoma. While in many cases neither spine cells nor keratohyaline granules are demonstrable, in others both these criteria of true squamous cell epithelium are present, and pearl formation is added. The squamous cells usually appear in foci in the alveolar lining, where the sharp transformation of cylindrical into flat cells may be followed. Such cell foci usually fail to show hornification. Rarely, all the adult characters of true acanthoma are observed."

Ewing (1928) states that at least three primary adenoacanthomata of the corpus, all in elderly women, have been described (Gebhard, Kaufman, Flaischlen). Meigs (1922) found that at the Free Hospital for Women, Brookline, Massachusetts, since 1903, 44 cases of adenocarcinoma of the uterus have been encountered in 9,566 operations, and of these one was of the squamous celled type.

Zeller (1885) was the first of modern authors to give particular attention to squamous celled adenocarcinoma. He claimed to have found 63 cases in the literature in which this type of growth involved the uterus, the cervix, or both. However, many of the descriptions in these early cases are inadequate, thus leaving the true type of the growth in doubt. It is highly probable that a number of these cases were not true acanthomata in view of the fact that so few cases of this kind have been described in the more recent literature. Zeller called the condition "psoriasis uterina" and, indeed, in the early reports the term adenoacanthoma is not employed.

There soon followed reports by Piering (1887), Benckiser (1891), Gebhard (1892), 2 cases, Pfannensteil (1893), Flaischlen (1895), Hofmeier (1895), 2 cases, and Gellhorn (1897).

Gebhard's case, referred to by Ewing, occurred in a woman, aged 66 years. He states that the growth showed both epithelial pearls and cancroids. A complete hysterectomy was performed and the patient recovered.

Flaischlen reported a typical case, reviewed the literature, and classified squamous celled tumors of the uterus into three categories, largely dependent upon the location.

In 1901, Emmanuel collected 9 cases apparently meeting the requirements of true acanthoma, to which he added a case of his own. In 1907, Schauenstein listed 27 cases culled from the literature, and described 3 additional cases which came under his observation, one of these being a primary squamous celled adenocarcinoma of the cervix; in the second, cancroids were found in a growth in the corpus uteri; while, in the third, the cervix and the entire corpus were

involved in a typical adenoacanthoma. Cases not already listed to which he refers are those of Opitz (1899), Hitschmann (1903), and Kraus (1905). In these cases both the cervix and the corpus were involved.

Additional cases were reported by Sitzenfrey (1907), Kaufmann (1911), Buttner (1911), Schottlaender and Kermauner (1912). The last named authors published a monograph on malignant tumors of the cervix and uterus, in which they describe a case of squamous celled adenocarcinoma which involved both the cervix and uterus.

The chief interest and discussion concerning this type of malignancy centered in the origin. The situation is summarized briefly by Ewing as follows: "They arise in the portio, the cervical canal, or in the endometrium, and their histogenesis has formed the topic of much discussion. It is now rather apparent that such structures do not, as a rule, signify a multicentric origin from cylindrical and squamous cells, and do not require an original heterotopia of squamous cells, but that metaplasia of cylindrical tumor cells into squamous is a frequent characteristic of uterine growths as of some other processes in the endometrium. Hitschmann has shown that the metaplasia is complete, producing spine cells and keratohyalin. On the other hand, Hauser (1913) reports a case of adenocarcinoma of the cervix with a separate acanthoma of the portio, showing that with multicentric origin tumors may remain separate. Finally, in several cases the histological study strongly suggested that the adenocancroid developed from a double origin and not through metaplasia (Hofmeier, Buttner, Sitzenfrey). In chronic erosion I have observed rarely acanthoma arising from the squamous lining and precancerous changes in the neighboring group of cervical glands. It thus appears that a variable histogenesis may be assumed for this type of growth.

The case described by Kaufmann, to which Ewing refers as a true acanthoma, was a combination of superficial acanthoma with adenocarcinoma, and he held that this implied a double origin from previously altered superficial lining cells and from gland cells. This same case was studied by Eckhardt, who came to an entirely different conclusion; namely, that both types of growth were of the same origin—the cylindrical epithelium of the uterine glands.

During the period of time which we have reviewed, the only true case of adenoacanthoma recorded in this country seems to be that of Noble, published in the *Transactions of the Gynecological Section of the College of Physicians of Philadelphia*, in 1903. Hirst mentions still another case reported by Batcheler. Both of these cases were combinations of adenocarcinoma and adenoacanthoma.

In 1915, Ladinski described a uterine growth of this type among the cases which he cited in a paper on the "Complete Removal of Adenocarcinoma of the Uterus by Exploratory Curettage," but he made no comments on this particular type of malignancy.

The results of the microscopical examination in his case were as follows: "The material removed consisted of two fair sized masses. The larger mass consists of glandular spaces irregular in size and conformation. These spaces are lined by two or more layers of epithelium which vary from low cuboid to high cylindrical. The epithelial cells vary greatly in size, are rich in chromatin, and show few mitotic figures. In places the epithelial cells completely fill the alveoli, which are irregular in size and contour. The stroma is abundant and consists of fibrous tissue infiltrated by many round cells, and in many places distinct muscle fibers are visible. In the second specimen are a half dozen small masses the size of a millet seed. Some of these masses show solid nests of epithelial cells similar to those above described embedded in stroma resembling the stroma of uterine mucosa. In some places the lumina are so nearly filled with epithelium as to resemble a carcinoma of the solid variety."

Meigs, referred to earlier in this paper as having found one case of adenoacanthoma among 44 cases of adenocarcinoma, described the growth in this case as an epidermoid carcinoma. "The specimen showed no carcinoma in the cervix or below the internal os, yet the picture under the microscope was that of a large mass of epithelium with two or three early pearl formations." Meigs stated that this type of growth is rare and that this was the only case that had come to his notice. He thought that it was probably due to a metaplasia from the cancer cells growing in cords to a squamous epithelium, as sometimes takes place in carcinoma of the cervix. Mallory, who examined this specimen, stated that in the fundus these tumors may grow in solid alveolar or gland form.

The most complete historical review of the subject that has been published is that of Walther Schmitt (1924). He also reported a case of his own, giving a full description of the microscopical findings. His patient was a woman, aged 71 years, who following a complete hysterectomy made a good recovery. The growth which was removed measured 8 by 7 centimeters and consisted of thick plaques of pavement epithelium. It

involved the endometrium and entirely filled the uterine cavity. There was round celled infiltration with fibrous cords. The flat epithelial layers were irregular and disorderly and often dipped into the musculature. There were areas of changing cylindrical cells in disorderly arrangement, with highly staining nuclei, showing degeneration and vacuolization.

A case of this kind has also been reported by Babes and Paulzo (1926), who call attention to several additional cases in the literature (Limbeck, Kleinhaus, Lehman, Stein). Limbeck's case showed both adenocarcinoma and squamous cell areas with epithelial pearls, and he assumed a double origin for the two types of growth. The case described by Kleinhaus showed involvement of the entire uterine cavity. In certain places a transformation of glandular epithelium into pavement epithelium could be observed, and in places the growth appeared as solid carcinoma. In Lehman's case the growth showed in some places the characteristics of adenocarcinoma and in other places pavement epithelium. In Stein's case there were two distinct carcinomata, and he holds that the cylindrical cells at the base of the growth become stratified and then this epithelium develops squamous carcinoma.

The case described by Babes and Paulzo was unusual in that the patient was only 29 years old, whereas all the other cases seem to have been in elderly women, at least over 50 years of age, with the exception of one case, a woman of 42 years (Meyer). In this instance the growth consisted of solid carcinoma and adenoma, and in places the cylindrical epithelium was replaced by squamous epithelium. These authors think that the squamous carcinoma developed from the stratified epithelium in the cervix, but concede that the origin is problematical.

It is evident from the foregoing review of the literature that an estimation of the exact number of cases of true adenoacanthoma of the uterus is rather difficult, inasmuch as all the characteristics of this type of growth have not always been found. A considerable number of writers have not mentioned pearl formation, and it is quite possible that in some instances this characteristic has been overlooked. The review, however, leaves no doubt that in our case all the requisites of true adenoacanthoma are fulfilled.

In the cases thus far reported no late postoperative history has been recorded and no mention whatever is made of metastasis to the mediastinum or the lung. This is not surprising, for it is well known that malignant growths of the mediastinum are exceedingly infrequent, tumors in this locality being usually dermoid cysts.

Martini (1914) was able to collect a series of 14 mediastinal tumors, of which 3 were syphilitic, 2 tuberculous, 3 lymphosarcomata, 2 sarcomata, 1 carcinoma, 1 thymus, 1 retrosternal thyroid, and 1 was undiagnosed. Curtis Burnham, writing in 1917, stated that up to that time no surgical cure of a malignant tumor of the mediastinum had been reported, though several cures by means of the X-ray had been claimed.

In 1920, Mix stated that mediastinal tumors are usually secondary to carcinomata of the breast and lung, but occasionally they are derived from tumors of the bones, gall bladder, and stomach.

A very satisfactory classification of tumors of the chest and thorax has been worked out by George H. Heuer (1929). He writes: "Of tumors in the chest, and particularly in the mediastinum, there are relatively few. They may be classified as: (1) dermoid cysts, which arise near the hilum of the mediastinum, do not affect the trachea, and show in the X-ray plates as clean-cut shadows; (2) other cysts such as echinococcus, which are very rare; (3) connective tissue tumors, lipomata, fibromata, chondromata, etc.; (4) malignant tumors of which there really are but a few, lymphoblastoma, sarcoma, carcinoma."

Heuer spent 2 years collecting mediastinal tumors which have been reported in the literature, and states that primary carcinoma in this region of the body is much more infrequent than the literature would lead one to suppose. Between 1896 and 1901, Lorish found only 2 cases reported, and between 1901 and 1907 Christian found 1 case.

Acanthoma of the lung, on the other hand, seems not to be such an unusual condition, and is only incidentally of interest in connection with our case, in which it was apparently an extension of the mediastinal tumor. Ewing, writing of tumors of the lungs, states that "in many cases squamous epithelium is mingled with cuboidal and cylindrical cells, as in Kretschmer's case. Wolf (1895) found 8 acanthomata and 7 cylindrical celled tumors among 15 of bronchial origin. Ernst describes a papillary tumor of the lungs which contained hornifying squamous epithelium. Tumors of the lung arise from the bronchial mucosa, the bronchial glands, and the alveolar epithelium. Froelich found extensive bronchial pachydermia with squamous cell cancer. It is especially about tuberculous centers that squamous alterations are observed, and in these situations squamous cell cancer is most frequent."

SYMPTOMATOLOGY

In addition to the unusual type of growth in our case and the unique location of the metastasis, the symptomatology in connection with mediastinal tumors is of interest. The usual symptoms of tumor in this region are headache, vertigo, œdema, cough, dyspnœa, and enlargement of the superficial veins of the abdominal wall and chest. Mix states, however, that if the tumor is in the posterior mediastinum, it will produce few pressure signs until it has reached a very large size. In this case the only physical signs are possibly slight bulging of the posterior or lateral chest wall with limitation of the respiratory excursion, dullness, and increased sense of resistance, slight suppression of respiratory sounds with fairly good conductivity of the cardiac sounds. The difficulty in making the diagnosis in our case is thus readily explained. All writers on mediastinal tumors emphasize that the X-rays offer the only means of reaching a definite diagnosis and urge a more careful study of the symptomatology in these cases.

SUMMARY

A case of the rare condition of adenoacanthoma of the uterus is reported. A unique feature of this case was metastasis to the mediastinum and lung. A fairly thorough review of the literature failed to reveal any instance of this complication with the type of neoplasm under consideration.

The patient was a married woman, aged 42 years, whose symptoms and signs suggested carcinoma of the uterus. When hysterectomy was performed in 1927, the entire uterine wall was found to be invaded by carcinomatous tissue. Microscopically the growth was composed of glandular and squamous elements. Up until 2½ years after operation, there was no evidence of local recurrence.

A little more than 2 years after the hysterectomy, the patient complained of gastric pain, loss of appetite, and difficulty in swallowing. There was rapid loss of weight. Physical signs in the chest suggested fluoroscopic examination, which revealed a smooth, round, sharply circumscribed mass in the mediastinum. It was thought to be a cyst but, when removed, proved to be an adenoacanthoma of the lung and posterior mediastinum, secondary to the earlier growth in the uterus. The patient made a good recovery from the operation.[1]

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[1] August, 1930, at time of proof-reading: Patient has died since and no autopsy has been obtained.

MECKEL'S DIVERTICULUM

R. M. HARBIN, M.D., F.A.C.S., ROME, GEORGIA

THE records of the clinic of the Harbin Hospital for a period of 20 years show that in the relative incidence of postoperative deaths from all diseases, appendicitis leads with a proportion of 24.5 per cent, the next highest percentage being for intestinal obstruction with 16.1, and that of these 10 per cent were due to Meckel's diverticulum. This record shows further that indirectly diverticula are the cause of more postoperative deaths than goiter, osteomyelitis, or hernia.

Wellington reports that 6 per cent of the cases of intestinal obstruction are caused by Meckel's diverticulum. Halstead reports 69 cases of obstruction from diverticula with a mortality of 59.1 per cent. It is evident that Meckel's diverticulum is the most serious cause of obstruction. Mortality statistics are at times indefinite in that they fail to record the cause of obstruction, and such omission tends to obscure the degree of incidence of diverticula. In other cases the variable frequency with which diverticula are found and reported is perhaps due to the fact that the surgeon fails to discover the lesion in his routine inspection in connection with an operation for some other cause. Notwithstanding our deep interest in the subject, 3 cases in our series, or 15 per cent, were not noticed at the primary operation. It would seem probable from our experience, therefore, that the majority of diverticula recorded are those that are thrust into the field of operation.

Postmortem records show in general an incidence of diverticula of about 2 per cent but the incidence reported by different surgeons varies from 0.14 to 3 per cent. The degree of incidence would probably be found to be greater in postmortem examinations of younger subjects, but I have tried in vain to locate in medical literature reports which would confirm this statement.

While the general incidence is given at 70 per cent for males, our cases show only 35 per cent males. Bunts cites a case reported by Dowse who found a diverticulum in a woman 72 years of age. In a review of about 40 articles in the literature I found only one case, that reported by Coléman, in which diverticulum was correctly diagnosed before operation. Bettman and Blum report a case of impaction of Meckel's diverticulum that was manually relieved without excision but after recovery from operation X-ray examination failed to reveal a diverticulum. Miles F. Porter says that Meckel's diverticulum is a greater menace to its possessor than is the diseased appendix.

If it were possible to ascertain the history of umbilical disorders in the first few weeks of infancy we would probably find that such disorders were associated with the presence of a Meckel's diverticulum which sooner or later would manifest itself. I recall the case of a boy 12 years old whose mother I attended when he was born and whom in the first 3 weeks of life I treated for a discharging sinus and a pedunculated growth of the umbilicus. He was operated upon for acute appendicitis and in the process of operating a conical band was found extending from the ileum to the umbilicus. Balfour, in a personal communication, says: "The only cases in which we have suspected Meckel's diverticulum and have found one later at the operation have been those in which there has been a history of discharge from the umbilicus."

While certain anatomical defects arising from faulty embryological development are well known, the peculiarities of the arterial supply of diverticula are not usually recognized because, so far as the circumference of the ileum is concerned, the location of the arteries varies. In 1 case in which the pouch was located laterally we were able to demonstrate that the circulation was by no means symmetrical as to the summit of the mass because increase in size was accomplished at the expense of one wall of the ileum. A clamp was placed on the mass just above the line of resection and it was found by slight incisions on the two sides that one bled while the other did not. Had excision been done at the level of the clamp the circulation would have been defective on one side. We have had two such cases ascribed to defective circulation.

The accompanying diagram (Fig. 1) shows the pouch rotated forward, clamped at *S* parallel to the ileum well above the line of proposed resection. After slight incisions the anterior and upper wall *O* bled considerably, while the posterior surface *I* bled from the veins and then stopped, thus indicating that the mesial line of anastomosis of the blood supply was well below the posterior incision.

No organ in the body is so liable to dysfunction as is the ileum because of the thinness of its walls,

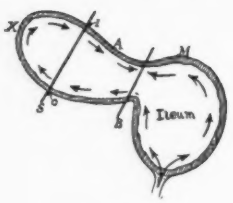

FIG. 1.

the multiplicity of its convolutions, and the great laxity of its mesenteric attachment. This anatomical condition can be verified by observing that a barium meal while in the ileum usually lies clumped almost entirely in the right lower abdomen and pelvis. Textbooks usually show the ileum in a middle location. These mechanical conditions contribute the greatest factor in mortality in peritonitis and obstruction. This being true it is easy to see that the presence of a distended Meckel's diverticulum, even when not definitely inflamed, increases the difficulty in that the peristaltic wave is disturbed. In the absence of other pathological conditions, this element of dysfunction can frequently be conserved for a time at least.

In one patient operated upon for a definite acute appendicitis, a diverticulum was found to be distended to the size of a small pear, and, when replaced for removal of the appendix, it was again found with some difficulty because it had shrunken to what appeared like a small knuckle of ileum. This case illustrates the degree of dysfunction of ileum when encumbered with such an appendage; obviously such an attenuated structure becomes more liable to inflammatory disorders when aggravated by certain mechanical factors.

When a Meckel's diverticulum is found at operation and its presence has not been suspected previous to operation, it is usually referred to as giving symptoms or not. Such classification is obviously unreliable for abnormal conditions, especially as concerns the ileum, and can hardly ever be referred to as symptomless. Therefore since diverticula alone cause symptoms, it is evident that in the presence of co-existing pathological conditions, the symptoms will become aggravated by the diverticula. This phase of the subject is of greater importance from a surgical standpoint than is usually recognized.

In our clinic the presence of Meckel's diverticulum was noted in 19 cases. In 507 consecutive laparotomies routine search was made for diverticula and their presence was noted in 7 cases, or 1.3 per cent. Of the 507 cases, operation was done in 314 for acute conditions, and in 193 elective operations were done. Of these 7 cases of diverticula, 5 were in the acute condition group and were giving evidence of causing or contributing to symptoms and 2 were in the elective group and seemed quiescent.

As to the location of the diverticula on the ileum, 30.9 per cent were peripheral, 69.1 per cent were lateral, and 28 per cent were pedunculated. The youngest patient was 3 years old and the oldest 36 years, the average age being 22 years. The pre-operative diagnosis of this series was positive in only 1 case. From this observation we are led to the conclusion that, in the majority of cases, the condition attains a state of surgical importance before the patient reaches the age of 36 years and that the 0.7 per cent remaining of the 2 per cent general incidence belong to those slighter deformities that go through life without showing trouble. None of these patients was hæmorrhagic or had hernia.

A great degree of practical interest centers in the fact that 5 patients required secondary operations; in 3 cases the diverticula were overlooked in the course of other operation and in 2 cases of acute diverticulitis there was postoperative obstruction as a result of faulty technique. It should be remembered that overlooked diverticula are not an infrequent cause of failure to relieve patients who have been operated upon for other conditions. On a theoretical basis, an uncomplicated disease in the abdomen is a rare entity, for practically every major lesion carries with it certain associated pathology. Fortunately, however, removal of the major cause usually favors spontaneous recovery from these consequent transient conditions, but when we have to deal with co-existing organic pathological conditions, such as diverticula, a more serious problem is presented and if the diverticula are not removed for certain reasons a record of their presence should be made for future consideration.

Barney calls attention to the fact that operations for acute abdominal conditions frequently fail to reveal the real cause which later may be found to be a Meckel's diverticulum. Hall reported death in 2 cases of frank appendicitis in which the wounds were closed without drainage and postmortem examinations revealed acute diverticulitis. In a series of 18 cases, Coleman cites 2 in which diverticula were overlooked at appendectomy and secondary operation was necessary. In a case of salpingectomy a diverticulum was noted but was not removed, and the patient died 2 months later from obstruction.

Winslow mentions the case of a boy 12 years of age who was operated upon for acute appendicitis and 2 years later developed an acute abdominal condition caused by diverticulitis.

It is our belief that in this day of early operation surgeons generally are too conservative in searching for co-existing pathological conditions. We believe that mere inspection of the gut *in situ* is not sufficient and that, while sometimes impracticable, the lower limb of the ileum should be lifted out to determine the presence or absence of diverticula. If this further investigation had been made, secondary operation would not have been necessary in the 3 following cases.

CASE 9826. Male, aged 28 years, a healthy looking farmer was admitted to the hospital October 8, 1929. He had complained 2½ days of pain in the right abdomen, with vomiting and localized tenderness. He had a total leucocyte count of 22,350 and urinalysis showed considerable pus and albumin. A diagnosis of acute appendicitis was made and operation through a gridiron incision revealed a beginning necrosis of the appendix pasted to the postcæcal wall. The wound was closed without drainage. The diagnosis of acute appendicitis was confirmed. No search for other lesions was made. Convalescence was painful and was attended with considerable fever. It was thought that a localized peritonitis existed. Patient was dismissed, however, on the eighteenth day without an infection of the incision. Five days later he returned to the hospital with a tentative diagnosis of intestinal obstruction which subsided in 4 days. Eleven days later he was again admitted with the same diagnosis and the pain subsided. Then he was advised to have a second operation and at this time a cone-shaped diverticulum of 2½ inches was found about 2½ feet from the ileocæcal valve. Resection of the diverticulum was done so as not to leave any indentation of the normal outer curve of the ileum, and the patient has remained well since. He remarked that the later pains were different from those of the acute appendicitis and that he had been subject to transient attacks of colic with vomiting for 13 years, sometimes once a month but at one time he went 2 years without symptoms. As he was a healthy man there were no other conditions that would account for his symptoms.

CASE 2372. A young unmarried woman, aged 19 years, was operated upon for a ruptured and gangrenous appendix on April 23, 1921, through a right rectus incision, with drainage. She was dismissed 17 days later. On May 1, 1921, she returned to the hospital with symptoms of obstruction which subsided on fourth day. On January 2, 1923, she was again admitted to the hospital with a postcæcal abscess which was drained through a lumbar incision. She was discharged 14 days later. On July 26, 1924, she was again admitted for operation for chronic intestinal obstruction at which time numerous adhesions were noted and in their midst a Meckel's diverticulum was found buried 14 inches from ileocæcal valve and pasted to the ileum. After resection of the diverticulum the incision was closed without drainage and the patient has remained free from abdominal symptoms since.

CASE 6838. A married woman, aged 36 years, 10 years previously, when single, had an appendectomy and a salpingectomy which gave her considerable relief from dysmenorrhœa and abdominal pain. On February 15, 1927, she was re-admitted to hospital with a return of these symptoms and with menorrhagia. At this time she was more or less an invalid. Operation was done and revealed dense adhesions of omentum to the ileum, cæcum, and right ovary. The severing of these adhesions created considerable hæmorrhage. In the mass of adhesions was found a Meckel's diverticulum about 2½ inches long and more or less tubular but expanding at its tip. The right ovary was removed and the diverticulum was resected. Convalescence and subsequent health were normal. It was easy to believe that the diverticulum in this case was the mischief maker.

As already stated the vascular supply to diverticula varies widely but under all circumstances is less than that of the ileum so that in the absence of acute conditions this lack of vitality even in the presence of adverse mechanical conditions can usually be conserved. In the presence of acute diverticulitis, however, these handicaps become greatly aggravated and for that reason offer an unfavorable field for plastic surgery.

A boy aged 20 years was operated upon on the diagnosis of acute appendicitis. A negative appendix and a somewhat pedunculated diverticulum attached to the lateral wall of the ileum were found. It is probable that one wall of the pouch had a defective blood supply with a seemingly unavoidable indentation of the outer curve of the ileum after resection. Acute obstruction developed on the third day and required resection and lateral anastomosis of the ileum. Recovery was prompt.

In another case, subacute diverticulitis occurred in a girl 16 years old. A large pouch with a broad base was found adherent to the ileocæcal valve and to the right tube and ovary. The pouch was resected and convalescence was uncomfortable. After this she suffered more or less for 7 months at which time she returned to the hospital with symptoms of obstruction which at operation were explained by a characteristic deformity in the presence of adhesions. Five months later she was operated upon again for obstruction. Resection of the ileum primarily would probably have saved these subsequent operations.

The technique of operation for diverticula cannot always be predicated because of the aberrant types of vascular supply to the parts in the field of operation. It is of first importance that resection should be made so as to leave the ileum in as near as possible its normal peripheral contour. The larger the base of the pouch the higher will be the level of resection, so as to allow sufficient room for the final row of interrupted sutures so that no indentation in the peripheral curve of the gut will occur. Any good method will perhaps be sufficient for the pedunculated types but if the base is broad and the diverticula is laterally located it may sometimes be better first to resect the ileum. The postoperative treatment should be modified to meet the hazard of dysfunction. In acute cases especially the postoperative treatment of diverticulitis is essentially the same as that for peritonitis—an effort should be made to minimize peristalsis so that nature can better make conservative adjustment.

SUMMARY

1. The average age of 19 patients with Meckel's diverticulum was 22 years; we believe therefore that the accepted general rate of incidence of 2 per cent would be greater if statistics were limited to the first few decades of life.

2. Defective blood supply and mechanical obstacles contribute to dysfunction thus making the diseased conditions more hazardous; faulty resections at times necessitate secondary operations especially when other lesions are present.

3. Overlooked diverticula are a more frequent cause of failure to relieve patients by operation than is generally supposed. The presence or absence of diverticula should be routinely noted in the operative record.

4. The presence of diverticula was recorded in 1.3 per cent of 507 consecutive laparotomies when search was practicable and these diverticula were the cause of 10 per cent of all postoperative deaths from intestinal obstruction.

5. On account of dysfunction the technique of the postoperative treatment of peritonitis should be applied to all cases of resection of diverticula.

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CORRESPONDENCE

"THE INFLUENCE OF THE TRANSVERSE UPPER ABDOMINAL INCISION ON THE INCIDENCE OF POSTOPERATIVE PULMONARY COMPLICATIONS" BY DANIEL FISKE JONES, M.D., F.A.C.S., AND W. L. McCLURE, M.D., F.A.C.S., BOSTON

Through an error in our Editorial office, the residence of Dr. W. L. McClure was incorrectly stated in the article entitled "The Influence of the Transverse Upper Abdominal Incision on the Incidence of Postoperative Pulmonary Complications." At the time this paper was written Dr. W. L. McClure lived in Boston and was an associate of Dr. Daniel Fiske Jones, the senior author of the article which appears on pages 208–212 of the August, 1930, issue. We regret this unfortunate error especially since Dr. McClure was killed in an automobile accident shortly after the article was sent to us.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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DECEMBER, 1930

RAMBLES IN EUROPE IN 1839

FEW essays of one hundred years ago are as pertinent today as the day they first appeared. The following excerpts from *Rambles in Europe in 1839* by William Gibson, professor of surgery, University of Pennsylvania, are fine examples of writing of perpetual interest:

"Distant three thousand miles from the fountains of medical science and literature, how few of us have the opportunity of crossing the Atlantic and of ascertaining, personally, the exact position of writers with whose works we may be, possibly, very familiar—works we receive in six or eight weeks after publication. Yet, what do we know, in many instances, of the age, standing, or experience of the writer? He is a mere boy, perhaps, fresh from his studies, may have received a good education, is possessed of native talent, very ambitious, and determined to force himself, at once, into notice—by writing a book. Accordingly, he rakes up authorities in every direction, uses the scissors freely, manufactures cases to suit his purpose, and compiles a volume, which, not selling at home, where he is unknown, or rather known, is shipped off to foreign parts, and too often swallowed, greedily, by those as young and inexperienced as himself. Or the work may be, really, from the pen of an experienced person, one, however, so eccentric, so peculiar in his views or notions, so full of prejudices, so connected with medical politics, or parties, so inaccurate, by nature, or from interest, in his statements, so determined to acquire a reputation by novelties, and to accomplish what the best authorities have deemed impossible, as to spare no exertions calculated to answer his end. Too many persons of each description are to be found in all parts of Europe, with whose works our public and private libraries are filled to overflowing, generally through the medium of reprints by our booksellers, all which are devoured by students, who only discover too late that their labor has been thrown away. In other words, many a man looms largely at a distance, or is well thought of, who has no reputation at home, or if so, only of equivocal, or possibly worse than equivocal, kind."

Gibson's graphic descriptions make the great surgeons of the day live and move across the pages of his book. His accounts of Liston and Velpeau furnish two excellent examples.

LISTON

"In a private room we found a respectable lady, her husband, and daughter, who, not meeting him at home, followed to the hospital to obtain his opinion respecting a cancerous mamma, and expressed strong desire to have it removed. He examined the breast very closely, and also the glands of the axilla, and finding the latter enlarged, immediately said,

'My dear madam, do not suffer any one to touch you with the knife; let it alone and you may yet live for many years.' The lady and her friends implored him to remove it, but he remained inflexible, and said, 'If I cut it out it will return in three months, and you will die; if I let you alone you may live for a long time.' It was just such a case as many a surgeon in Europe, and in this country, would have attacked by the knife without ceremony, and it gave me a better opinion of Liston's judgment and abilities than I should have formed, under other circumstances."

VELPEAU

"I had often heard of Velpeau as a homely, ungainly personage, with grizzly hair standing up like a shoe-brush, rough in his manners and careless in dress. I found him, however, polite, agreeable, lively, easy, and genteel, dressed plainly, but with as much neatness as most other gentlemen. He sat for half an hour conversing with great intelligence and good humour on various subjects; asked numerous questions respecting our medical men, and his former American pupils, whom he named and spoke of with pleasure. In referring to his numerous works, and expressing my surprise that he should find time, engaged as he was in hospital and private practice, to read and quote so many English, American, and other foreign books, he replied with an honesty and candour I did not expect, 'Oh, my dear sir, you see how little I know of your language, it would be impossible for me to read all these books myself, but I have excellent young friends among your countrymen, and students from all parts of the world, and get them to read for me and furnish translations and extracts, and in this way appear as learned as you have been pleased to consider me.' I was delighted with this amiable frankness, and afterward took every opportunity of seeing him at his house and at La Charité, where he is principal surgeon. His history is an extraordinary one and calculated to make a strong impression upon a student who has experienced the hard usage and buffetings of this world, as it will convince him there is no situation in life however humble, no circumstances however difficult, no misfortunes and entanglements however complicated, he may not extricate himself from and rise to the highest eminence, provided he is endowed with talent, energy, enterprise, and good conduct.

"I was walking with an old Philadelphia friend in the Palais Royal, in quest of a watch, and struck with the open and honest physiognomy of a middle aged man, whom we observed through the window so busily engaged at his work as not to perceive us, determined to enter and examine his commodities. After selecting an article of beautiful workmanship, such as we had not seen in any other establishment, demanding the price, and then, according to usage, endeavouring to get at the lowest sum, the man, with a deep sigh and most disconsolate look, said that his profession was a most unfortunate one—that for years he had toiled from morning till night poring over the wheels and springs of watches with magnifying glasses, until he had nearly put out a pair of the finest and sharpest eyes God ever made, and by long sitting had injured his limbs and impaired his constitution. 'Oh,' said he, 'that I had been a surgeon, how different might have been my situation!' Then turning, and looking us full in the face, he continued, 'Gentlemen, I am a poor individual, without fame or consequence, but my history, inasmuch as it is connected with that of a dear friend, whose reputation is well known the world over, is nevertheless a singular and interesting one, and for his sake, if you can spare time, I will relate it to you.' Struck with the manner and earnestness of

the man, and favourably impressed toward him, we took seats in his small shop and listened to his narrative. 'I was the son,' said he, 'of a poor miller, and the father of my friend followed the occupation of blacksmith in the village of Breches and province of Loire, and at an early age we were both initiated in the mysteries of our paternal vocations, he shoeing horses, and I grinding grain from morning till night. In spite, however, of the severe labour to which my friend was exposed, he devoted many hours of the night to improving his mind, and twice a week attended a country school three miles off. His father's library consisted of two books—the complete drover and a volume of medical receipts—which the young blacksmith was so enamoured of as to commit to memory, and from that period turned his attention to medicine. He continued, however, to shoe horses, and prescribe for their diseases until his twenty-third year, when growing tired of such labour and burning to distinguish himself in higher pursuits, proposed to me to leave our native village and repair to the Capital, where he was sure, he said, we should both meet with occupations worthy of our toil.

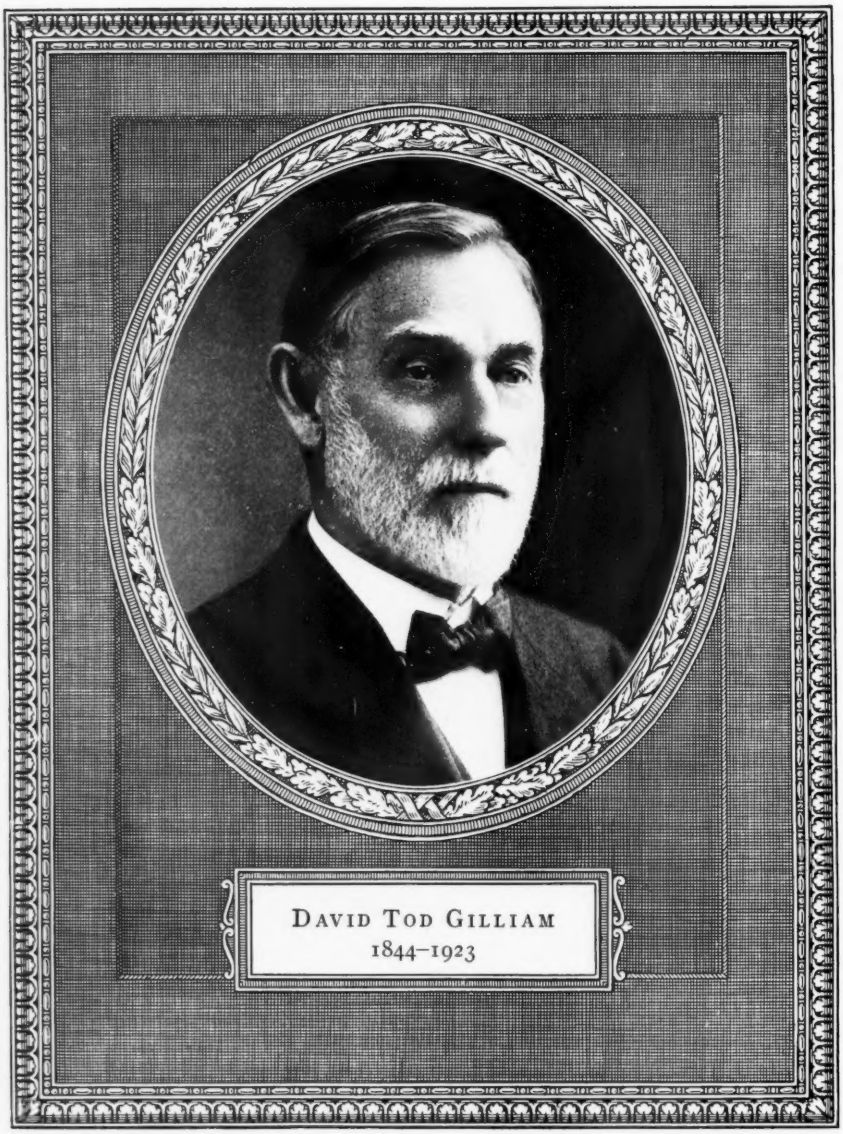
"'With scanty means and slender wardrobes fastened to our backs, we commenced our journey on foot, and after a time reached Tours, where the money of my friend giving out, he was obliged to remain and work at his trade, while I pursued my solitary way to the Capital, and meeting with no better employment took up with the villainous business of watchmaking. Several weeks afterward my friend arrived, and hiring for three francs a black coat, which did not fit, and contrasted strangely with his country garments, waited upon the celebrated Dubois—offering to become his pupil—who, impressed favourably, notwithstanding the ludicrous figure he cut in his long-tailed coat and sky-blue pantaloons, told him he might live among his servants and have the run of his kitchen for some weeks, until he could ascertain the nature and extent of his qualifications. The proposal was joyfully accepted, but before the expiration of the allotted time, my friend gave so many proofs of genius and talent, and worked with such assiduity and success as to astonish Dubois, and cause him henceforward to consider him as a companion and friend. From that moment the fortune of my village crony was made; for, under the excellent Dubois, he not only made astonishing progress in his medical studies, but was so diligent and untiring as to acquire in a short time such knowledge of the classics, and most of the languages of modern Europe, as to read them with facility. So much time, indeed, was devoted to all his pursuits as to render him very careless of his appearance and costume, and I remember how much mortification I experienced from perceiving that my master did not relish the occasional visits of my friend, and especially when he told me upon one occasion I ought to keep better company, for he was seriously afraid that ill-looking fellow would rob his shop. I endeavoured after this to prevail upon my old friend to attend better to his toilet, but he said such matters were beneath a man of science and proofs of a weak mind, and for his part, thought when a coat required brushing it was time to get a new one.

"'Since that period only a few years have elapsed, and my country friend, farrier, and blacksmith, is now at the head of the profession in Paris, a distinguished professor and hospital surgeon, the author of large and valuable volumes in every department of the profession, and withal, a man of fortune. And where,' he continued, 'am I? Still a poor miserable watchmaker in the Palais Royal, and the tenant of this pill-box of a shop, in which you are sitting.' 'And pray, Mr. Jaros-

say,' said I, 'may I ask who that friend of yours may be?' 'That friend, sir,' said he, slowly rising from his bench, putting forth his right arm, and stamping firmly with his foot upon the floor, 'That friend, sir, is no less than the celebrated Velpeau.'

"The next day I called upon Velpeau, and found him in his study behind a pile of books, which he was pitching with great vivacity from right to left, in search of authorities and quotations for a large work on surgery then in press. He showed me the translation of a letter I had sent him, at his request, detailing the results of certain operations in my own practice, and said he had obtained similar documents from other American surgeons. Before leaving I took the opportunity to ask if Jarossay's story was correct. 'Perfectly so,' said he, 'as far as it goes, he is still my friend, an honest man, and one of the best watchmakers in Paris, of whom you may purchase without hesitation.' I returned to the Palais Royal and secured the watch, and I would commend all in quest of such articles 'to go and do likewise.'"

JOHN C. A. GERSTER.



DAVID TOD GILLIAM
1844–1923

MASTER SURGEONS OF AMERICA

DAVID TOD GILLIAM[1]

DAVID TOD GILLIAM was born in Hebron, Ohio, April 3, 1844. After being educated in the common schools he enlisted at the age of seventeen for service in the Civil War. Within a short time he was wounded and captured by the Confederates, but he escaped to his father's home. From there he went back into service at the parole camp in Columbus, Ohio. Here he became seriously ill and was discharged and sent home to die. He recovered, however, and after a preliminary start toward educating himself for a business career in Cincinnati, Ohio, entered the Cincinnati Medical College from which he was graduated in 1871.

For several years he practiced general medicine in Nelsonville, Ohio. Here he had married Lucinda Ellen Mintun, October 7, 1866. In 1877 he was appointed professor of pathology in the Columbus Medical College. Within two years he resigned to accept the appointment of professor of physiology in the Starling Medical College, also located in Columbus, Ohio. Six years later, in 1885, he became professor of gynecology and obstetrics in the same school. After the reorganization of the medical schools in Columbus, he was made professor emeritus in gynecology in the Medical College of Ohio State University.

Few men have devised an operation so well known and extensively used as the Gilliam round ligament ventrosuspension of the uterus, or a modification of this operation. The names Gilliam and gynecology have been closely related for over thirty years.

Gilliam lived at a time when surgery was making great strides and the specialities were very young. Starting with general practice as a firm foundation, building upward by teaching pathology and physiology, he was well qualified to pursue work in his chosen speciality of gynecology. Dr. Gilliam gave to gynecology improved methods of diagnosis and surgical technique, as well as many superior instruments.

Dr. Gilliam was author of several books. The first was the *Pocket-Book of Medicine* in 1882. This was followed the next year by *The Essentials of Pathology*. During the next fifteen years he wrote many articles, the majority of which were

[1]Much of this material was obtained from "The Evolution of Gynecology" by Thomas S. Cullen in the Ohio State Medical Journal, August, 1924, 484.

related to the diagnosis and treatment of gynecological conditions. During this time he devised a new needle and vaginal speculum. In 1900, he published his famous article on the "Designation of the Operation of Round Ligament Ventrosuspension of the Uterus."

In the *American Journal of Obstetrics* for March, 1900, Gilliam said: "On the evening of Saturday, November 18, 1889, I received a copy of the *Journal of the American Medical Association* giving a description of Ferguson's method of suspending the uterus by the round ligaments. Thirty-six hours later I did my first case, and it was during the performance of this operation that I formulated and in part carried into effect the technique described below." Dr. Gilliam gave Ferguson due credit in his first report of the operation.

Dr. Gilliam's paper on "Round Ligament Ventrosuspension of the Uterus," read at the thirteenth annual meeting of the American Association of Obstetricians and Gynecologists and abstracted in the *Philadelphia Medical Journal* for September 29, 1900, outlined the following steps in his operation:

1. A median abdominal incision three or four inches in length, and at the usual site between the umbilicus and pubes.
2. The adhesions are broken up and the fundus brought forward, after which the patient is placed in the Trendelenburg position.
3. Seize the round ligament on one side and bring it to the opening. This may be done either by the fingers or by the aid of forceps.
4. Carry a thread under the ligament at a distance of about 1½ inches from the uterus. The free ends of the thread are brought out of the abdomen and secured by clamped forceps.
5. The other round ligament is secured in the same way.
6. Expose the rectus muscle near the lower end of the incision by retracting its sheath and by rolling it out of its sheath on the tips of two fingers applied to the peritoneal surface under it.
7. Select a point one inch external to the margin of the incision, and something over an inch above the symphysis, through which the perforating forceps specially devised for the purpose is thrust into the peritoneal cavity. The two fingers already in the cavity guard the instrument in its passage and place the thread which surrounds the ligament within its jaws.
8. The perforating forceps is now withdrawn after removing the clamp forceps from the thread, and both thread and ligament are brought up through the perforated wound in the abdomen.
9. While the ligament is held taut, fasten it into the wound by to-and-fro catgut suture passed deeply through the ligament and including the tissues on either side.
10. Treat the opposite side in the same manner and close the median abdominal incision. Rigid observance of all the rules of aseptic surgery is essential to prevent suppuration and only a small loop of the ligament should be drawn up through the wound.

In 1903, Dr. Gilliam's first book in gynecology, entitled *A Text-book of Practical Gynecology for Practitioners and Students*, was published. The last and fifth edition was published in 1916, with his son, Earl M. Gilliam, as co-author.

All of Gilliam's papers were clearly written and included his mistakes as well as his successes. A former student once said: "Candidly he related his mistakes as well as his successes, related his mistakes in little things that we might profit by them. He knew his subject thoroughly. He was a successful teacher because he possessed the faculty of making his subject so interesting, so plain, that in whatever other branches we had our troubles, we retained in our minds a good working knowledge of obstetrics and gynecology." In his paper "The Cancer Problem" published in 1917 Gilliam said: "If you are to have the co-operation of the laity, it will be necessary for you to cut out all unessentials, else they will be appalled at the complexity and take their chances with the disease. . . ."

His literary activities were not entirely confined to medical subjects. They include "Rose Croix" in 1906, "Richard Devereux" in 1915, and an unfinished work "God and Religion as Revealed in Nature."

Dr. Gilliam was gynecologist to St. Anthony's and St. Francis' Hospitals, Columbus, Ohio, member of the Columbus Academy of Medicine, the General Practitioner's Society, president of the Franklin County Medical Society, president of the Ohio State Medical Association, vice-president of the American Medical Association; vice-president of the American Association of Obstetricians and Gynecologists; member of the Pan-American Medical Congress and Ninth International Medical Conference.

On October 2, 1923, Dr. Gilliam died of cerebral hæmorrhage. His work is being carried on by his son, Earl M. Gilliam, and his grandson, David B. Gilliam, both practicing surgeons in Columbus.

Surgery and humanity are greatly benefited by the efforts of Dr. Gilliam. His work lives on in hospitals throughout the world. ROBERT ZOLLINGER.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D., F.A.C.S., Omaha, Nebraska

THE UNIVERSAL MEDICINE OF JEAN FERNEL

WITH the passing of Guy de Chauliac in the fourteenth century and Jacques Desparts (Jacobus de Partibus) in the fifteenth, medicine and surgery in France went into a decline that reduced them to almost nothing. The great schools of Montpellier and Paris lost their prominence and graduated no men that obtained any recognition. In surgery they taught barber surgeons to perform herniotomies and operate for the stone. Medicine passed into the hands of anyone who wished to practice it. The hospitals ran down until they became mortuaries or pre-mortuaries rather than hospitals. Boisseau writing of the condition of the Hotel Dieu in 1515 says: "In the infirmary which is only six fathoms (about thirty-nine feet) in width, there are six rows of beds, each bed about three feet wide. In each of these there are three or four patients who get in each other's way, and in the said infirmary there are seven or eight beds in which twenty-five or thirty children are laid, which children are weak and delicate because of the foul air which is in the said infirmary and the majority die so that in twenty only one recovers."

This was the condition of affairs in France that confronted Jean Fernel (Joannus Fernelius) when he decided to study medicine. Not a very alluring prospect, but one of which Fernelius must have had full knowledge. It is somewhat difficult to make sure why he studied medicine, particularly as it was not the subject in which he was most interested. Gurlt says he took up medicine because of family pressure brought to bear upon him. Baas thinks it was because he was not well and studied medicine to take care of his own infirmities, thus showing that he had no great opinion of the physicians of his day. In any event he had begun to study mathematics and philosophy at the College de Sainte Barbe at Paris in 1516 when he was nineteen years old. Three years later he began to teach philosophy at the college and at the same time to study medicine and in 1530 received his doctorate. During this time he had done considerable important work in mathematics and was still working on it but gave it all up to practice medicine. As the result shows, in this he was wise for he became the foremost physician in France, probably because he brought to medicine a mind that considered actualities rather than theories. His studies in mathematics had trained him to work with figures which were unalterable and his philosophical deductions had of necessity to correlate with material fact rather than abstract theory. Consequently in his work one finds little of the supernatural and mystical which was so prevalent at the time. Whether this was the reason or not, Fernelius' rise was rapid, and while still studying medicine he was called to court to care for Diana de Poitiers, the mistress of the Dauphin who later became King Henry II. His treatment was successful and his patient recovered. This gave him a definite place at court and he became the real physician to the King though he did not obtain the actual appointment until 1556 when the office became vacant through the death of its holder. He was not to enjoy this prominence for long; for after going through the siege of Calais in 1557 with the King he returned with the court to Fontainebleau and died the following spring in April, 1558.

Fernelius was the greatest physician France had produced up to his time. He appears to have been a most original thinker and likewise to have represented in himself two opposing types of ideas. In his medicine, so far as disease or injury are concerned, he is the mathematician dealing with fact. He believed disease is due to alterations in the component parts of the body and had nothing to do with the supernatural. In surgery, especially fracture, though he does not write much, what he does write is sound. He appears to understand fracture of the skull by contre-coup for he advises his readers to seek elsewhere for a fracture when signs of fracture are present and it cannot be found at the site of injury. When he comes to physiology he changes to the deductive philosopher and again in large part his reasoning is sound and logical. He believed the seat of the soul is situated in the brain and the nerves of sensation come from the brain itself while those of motion arise from its membranes. He held that the elements are actual bodies and the activating principle is heat residing in them.

Fernelius was well read in the medicine of the ancients and knew their works and ideas. He quotes them frequently but reserves to himself the right to assimilate the good and reject the bad with an impartiality to all, thus stamping himself as a free thinker who had broken away from the hide bound subjection to the dicta of his ancient predecessors and preferred to observe for himself and draw conclusions from his own observations.

Stillantẽ è Phœbi panacæam vertice monſtrat,
AEgrotis medicam tradere doctus opem.

H. Sur.

REVIEWS OF NEW BOOKS

ALTHOUGH Dr. Fowler calls his text *Tonsil Surgery*[1] it is chiefly an anatomical study of tonsils and their adnexa. One hundred and three illustrations in two hundred eighty-eight pages help to illustrate his dissections. Some of the plates are full page and in colors. As the author states, the book is designed to aid those who seek the best type of tonsil enucleation. Of these he describes four so-called classical operations, namely:

1. Partial dissection and snare.
2. Automatic instruments—no dissection.
3. Complete dissection without snare—semi sharp.
4. Complete dissection without snare—sharp.

These are illustrated step for step so that one might follow them easily.

In discussing the anatomical make up of the tonsils Dr. Fowler lays special stress upon the importance of the musculature especially the bundle he calls tonsilo-pharngueus which is composed of fiber of the palatopharyngeus caught in the mass of lymphoid tissue at the tonsil. It is the only muscle which is known to be attached directly to the capsule.

In addition to his anatomical studies Dr. Fowler has added a chapter on the evolution of the tonsil. The text also includes instructions on postoperative care, anæsthesia, etc. Indications for removal are discussed but no new light is thrown upon the problem of determining whether or not the tonsils are causing trouble. This to the reviewer seems to be the most important problem facing the laryngologist today.

Dr. Fowler's work is an excellent contribution to the anatomy of the tonsil and should be read by all men doing throat work.

JOHN F. DELPH.

FOR those complacent ones who are content with the perfection of present day surgery, there is no better antidote than a consideration of surgery 100 years ago. How different from our present teachings is what was then thought by serious minded men to be perfection. Surgery can never be stationary and 100 years from now the change may be equally great.

The New York Hospital, started by royal charter in the year 1771, is the second oldest hospital in America. It has always constituted a great school of surgery.

Doctors Pool and McGowan have contributed a most instructive study of the surgical records of 100 years ago.[2] The cases well illustrate the surgery of the time and the comments of the authors are full of interest.

Bleeding the patient to the state of syncope was referred to as "Bleeding to deliquium animi." As much as 120 ounces of blood were withdrawn from a patient in 10 days for lightning stroke. Ten grains each of calomel and jalap every 2 hours was not thought a too heroic prescription. Yeast poultices and bread and milk poultices were employed. Surgery was done without, of course, general anæsthesia, but opium was administered. An indication that this age was pre-Listerian may be found in the teaching that reducible hernia presented no surgical indication. Of interest was the hospital rule that no operation was undertaken except after consultation by all the physicians and surgeons. Earnest efforts were made to obtain postmortem examinations.

The illustrations are exceedingly interesting and well printed. The book will make a very attractive addition to every surgeon's library.

FREDERICK CHRISTOPHER.

IN his book on otology[3] Dr. Keeler has departed to a degree from the orthodox form used as standard reference and textbooks and has added new and unusual material. A very useful chapter is the one dealing with artificial aids to hearing. Here one can find a description of the various instruments on the market and can gain an idea of what might benefit a particular case. There are also two new chapters, one dealing with "The medico-legal aspect of otology" and "The ear in life insurance examination." Many of Dr. Keeler's points are illustrated by practical cases, some with both clinical and autopsy findings.

The book contains forty-five chapters with ninety original illustrations and fifteen colored plates. It is printed on good stock and the type is clear.

JOHN F. DELPH.

VOLUME VII in the series of Oxford Monographs[4] edited by Henry A. Christian has been written by Mosenthal. Its aim is to help the practicing physician in diagnosis and treatment of variations in blood pressure and nephritis. The author reviews the present conceptions of the physiologic dynamics controlling arterial pressure and the methods for determining it. The last half of the monograph which includes the chapters on the types of increased blood pressure and essential hypertension is very ably presented and should be well taken. At the end of each chapter, there is an excellent bibliography of the current literature on the subject, and this is one of the best features of the volume.

M. HERBERT BARKER.

[1] TONSIL SURGERY; Based on a Study of the Anatomy. By Robert H. Fowler, M.D. Philadelphia: F. A. Davis, 1930.

[2] SURGERY AT THE NEW YORK HOSPITAL ONE HUNDRED YEARS AGO. By Eugene H. Pool and Frank J. McGowan. New York: Paul B. Hoeber, Inc., 1930.

[3] MODERN OTOLOGY. By Joseph Clarence Keeler, M.D., F.A.C.S. Philadelphia: F. A. Davis Company, 1930.

[4] OXFORD MONOGRAPHS ON DIAGNOSIS AND TREATMENT. Edited by Henry A. Christian, M.D., Sc.D., LL.D. Vol. VII.—THE DIAGNOSIS AND TREATMENT OF VARIATIONS IN BLOOD PRESSURE AND NEPHRITIS. By Herman O. Mosenthal, M.D. New York: Oxford University Press, 1930.

IN a volume of 472 pages reprinted from the *Frankfurter Zeitschrift fuer Pathologie* is brought together the work upon the gas treatment, the chemistry, and the physiology of malignant tumors, which has been done by Professor Bernhard Fischer-Wasels in the Senckenberg Institute of Pathology of the University of Frankfort.[1] Malignant tumor cells differ from normal cells in many significant ways, here fully discussed, among which are their greater susceptibility to injury and their peculiar metabolism and respiration. In an effort to discover a means of destroying malignant tumor cells, the authors have used a gas mixture composed of 5 per cent carbon dioxide and 95 per cent oxygen. It is claimed that this mixture can be inhaled for several hours daily without danger. Numerous experiments with this gas mixture on cancer-bearing mice and its use in two human patients alleged to have carcinoma of the stomach and œsophagus, respectively, are reported, and diminution in the size of the tumors and clinical improvement are claimed. The technique of this treatment is described in detail.

The work is admittedly experimental, but the volume contains a great deal of very interesting and important information and is well worth reading with a critical attitude of mind.

J. P. SIMONDS.

[1] DIE GASBEHANDLUNG BOESARTIGER GESCHWUELSTE. By Dr. Bernhard Fischer-Wasels in collaboration with Dr. W. Buengler, Dr. J. Heeren, Dr. S. Heinsheimer, Dr. G. Joos. Munich: J. F. Bergmann, 1930.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

UEBER DIE AKUTE UND CHRONISCHE GELBE LEBERATROPHIE; MIT BESONDERER BERUECKSICHTIGUNG IHRES EPIDEMISCHEN AUFTRETENS IN SCHWEDEN IM 1927. By Prof. Dr. Hilding Bergstrand. Leipzig: Georg Thieme, 1930.

DISEASES OF THE SKIN. By George Clinton Andrews, A.B., M.D. Philadelphia and London: W. B. Saunders Company, 1930.

ROSE AND CARLESS' MANUAL OF SURGERY; FOR STUDENTS AND PRACTITIONERS. By Cecil P. G. Wakeley, F.R.C.S. (Eng.), F.R.S. (Edin.), and John B. Hunter, M. C. M. Chir. (Cantab.), F.R.C.S. (Eng.). 13th ed. New York: William Wood and Company, 1930.

THE PATHOLOGY OF DIABETES MELLITUS. By Shields Warren, M.D. With a Foreword by Elliott P. Joslin, M.D. Philadelphia: Lea & Febiger, 1930.

A TREATISE ON ORTHOPÆDIC SURGERY. By Royal Whitman, M.D., M.R.C.S., F.A.C.S. 9th ed. rev. Philadelphia: Lea & Febiger, 1930.

INTESTINAL TUBERCULOSIS; A STUDY OF THE SECONDARY ULCERATIVE TYPE. By Lawrason Brown, M.D., and Homer L. Sampson. 2d rev. ed. Philadelphia: Lea & Febiger, 1930.

A PRACTICAL MEDICAL DICTIONARY. By Thomas Lathrop Stedman, A.M., M.D. 11th rev. ed. New York: William Wood and Company, 1930.

HANDBUCH DER MIKROSKOPISCHEN ANATOMIE DES MENSCHEN. VOL. VII. HARN-UND GESCHLECHTSAPPARAT. PART I; EXKRETIONSAPPARAT UND WEIBLICHE GENITALORGANE. By W. v. Moellendorff, R. Schroeder. Berlin: Julius Springer, 1930.

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MINOR SURGERY AND BANDAGING; 20th ed. By Gwynne Williams, M.S., F.R.C.S. Philadelphia: F. A. Davis Company, 1930.

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SELECTED READINGS IN THE HISTORY OF PHYSIOLOGY. Edited by John Farquhar Fulton, M.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1930.

ELEMENTARY ZOOLOGY. FOR MEDICAL STUDENTS. By L. A. Borradaile, Sc.D. 2d ed. New York and London: Oxford University Press, 1930.

HISTOLOGY; FOR MEDICAL STUDENTS. By H. Hartridge, M.A., M.D., Sc.D., M.R.C.P., F.R.S., and F. Haynes, M.A. London: Oxford University Press, 1930.

LABORATORY MEDICINE. By Daniel Nicholson, M.D. Philadelphia: Lea & Febiger, 1930.

A TEXT-BOOK OF PATHOLOGY. Edited by E. T. Bell, M.D. Philadelphia: Lea & Febiger, 1930.

DISEASES OF THE EAR. By Philip D. Kerrison, M.D. 4th ed. rev. Philadelphia and London: J. B. Lippincott Company, 1930.

THE DEDICATION EXERCISES OF THE NEW BUILDINGS OF THE DEPARTMENT OF MEDICINE OF THE UNIVERSITY OF VIRGINIA OCTOBER 22, 1929. Charlottesville, Va.

LEHRBUCH DER CHIRURGIE. Dedicated to A. von Eiselsberg. Edited by P. Clairmont, H. v. Haberer, W. Denk, E. Ranzi. Vols. i and ii. Vienna: J. Springer, 1930.

MEDICAL AND SURGICAL REPORTS OF THE EPISCOPAL HOSPITAL OF PHILADELPHIA. Vol. vi.

DIAGNOSE UND DIFFERENTIALDIAGNOSE DER FRAUENKRANKHEITEN. By Dr. Walther Benthin. Berlin and Vienna: Urban & Schwarzenberg, 1930.

LES TUMERUS SOLIDES DE L'OVAIRE. By Dr. J. Luis E. de Mora. Paris: Gaston Doin & Cie, 1931.

ANÆSTHESIA AND ANÆSTHETICS. By F. S. Rood, M.B., B.S. (Dunelm.), and H. N. Webber, M.A., B. Chir. (Cantab.). New York: William Wood and Co.

CATALOGUE OF THE LOCKYER COLLECTION OF OBSTETRIC AND GYNÆCOLOGICAL SPECIMENS. Prepared and Published by the Donor, Cuthbert H. J. Lockyer, M.D., F.R.C.P., F.R.C.S. London: John Bale, Sons & Danielsson, Ltd., 1930.

CANCER OF THE LUNG, etc. By Maurice Davidson, M.A., M.D., B.Ch. (Oxon.), F.R.C.P. (Lond.). With a Foreword by Arthur J. Hall, M.A., M.D., D.Sc., F.R.C.P. New York: William Wood and Company, 1930.

OUR NEW PROGRESS; TWO ESSAYS, CORNUCOPIA AND CARITAS. By James Bayard Clark. New York and London: G. P. Putnam's Sons, 1930.

DER OPERIERTE MAGEN. By Prof. Dr. Hermann Meyer-Burgdorff and Dr. Walter Schmidt. Leipzig: Georg Thieme, 1930.